

Annual Report of Commissioners
on
Troy & Greenfield R.R. & Hoosac
Tunnel.

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ANNUAL REPORT

1867, 6 8 1 35
6 8 OF THE

COMMISSIONERS

ON THE

Troy & Greenfield R.R. and Hoosac Tunnel,
Commissioners

TOGETHER WITH THE

REPORTS OF CHIEF AND CONSULTING ENGINEERS.

BOSTON:

WRIGHT & POTTER, STATE PRINTERS,

No. 4 SPRING LANE.

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Commonwealth of Massachusetts.

COMMISSIONERS' REPORT.

To His Excellency the Governor, and the Honorable the Executive Council of the Commonwealth of Massachusetts.

The Commissioners on the Troy and Greenfield Railroad and Hoosac Tunnel respectfully submit herewith a statement on the condition of that work, December 1st, 1866.

The money on hand at the date of the last report was,	\$12,491 44
Received since, to December 1, 1866,	590,000 00
For materials and supplies beyond the sum deducted from pay-rolls,	30,603 13
For salaries of Commissioners, 15 months, to September 1, 1866,	7,216 71
	<hr/>
	\$640,311 28

They have furnished vouchers for payments amounting to,	\$626,815 80
And for their salaries,	7,216 71
	<hr/>
	634,032 51

Leaving a balance in their hands of,	\$6,278 77
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They are chargeable with the following amounts:—

Cash on hand, December 1, 1865,	\$12,491 44
Supplies and materials stated to be on hand at that date,	35,447 59
Money received from the State treasurer, . .	590,000 00
	<hr/>
	\$637,939 03

31235

This is accounted for as follows :—

Amount expended on buildings, machinery, and fixtures,	\$179,569 59
On the work of construction,	411,334 51
Cash on hand,	6,278 77
Leaving, as supplies unsold, and materials not charged to the work, the sum of	40,756 16
	<hr/>
	\$637,939 03

Of the items composing the last amount, an inventory is being taken, with a view to the disposal of all stock in the stores, as well as of the business of store-keeping.

For information relating to the cost, progress, and condition of work upon the tunnel, we refer to the accompanying report of Thomas Doane, the present chief engineer, appointed by the Commissioners in 1863.

The selection by you, in August, of Benjamin H. Latrobe, Esq., of Baltimore, as consulting engineer, is likely to prove useful to those intrusted with the conduct of the work. He is a gentleman of large experience, of excellent judgment, and eminently practical in the treatment of subjects presented for his consideration. His suggestions regarding the methods to be adopted hereafter, commend themselves alike to men of the same profession and to the skilful miner, and his desire to render available whatever has been provided as auxiliary to the plans of the Commissioners will tend to avoid the waste which might otherwise arise from the proposal of important changes.

In July last, proposals were made by the Fitchburg and the Vermont and Massachusetts Railroad Companies to lease the railroad from Greenfield to its terminus in the town of Rowe, near the eastern entrance to the tunnel, at an annual rental of \$30,000 ; this lease to continue in force until the completion of the tunnel, unless that work should be suspended by competent authority. Such lease was subsequently executed, under the direction of the attorney-general.

After amending the line in many of its details, lessening the curvature, and improving the location of some of the bridges,

the construction of the road was, on the 8th of October, with your approval, and under the advice of Mr. Latrobe, put under contract, to be completed for the sum of \$545,000. This does not include depot buildings, turn-tables, nor engineering expenses, which are estimated at an additional sum of \$45,000, and it is believed that the entire cost will not exceed \$600,000.

The contract provides for the opening of the road to Shelburne Falls by the 15th of November next, and throughout its remaining distance by the 15th of the following July.

About the middle of June, the automatic drills, referred to in previous reports, were introduced into the heading at the East End. For a few weeks, their operations were attended with reasonably satisfactory results, and they gave promise of complete success whenever the workmen should become familiar with this new system of drilling. Gradually they began to fail in strength; the incessant and rapid blows—counted by millions—to which they were subjected, appearing to granulate or disintegrate portions of the metals composing them, so that, in consequence of frequent changes for repairs which were found to be necessary, it became evident that these machines would prove of little practical value.

Having been produced by years of the combined ingenuity and toil of skilful men, at large expense to the State, after costly preparations in the river and on the mountain, and endorsed as they had been to some extent by the legislature of the Commonwealth, it was decided to employ them long enough at least to furnish the most satisfactory test of their capability for this service.

For these reasons, they were kept in use for six months, the expenses of operating being greater than those required by hand labor, and the progress during that period smaller than could have been made by the ordinary method of manual drilling.

At the time the conclusion was reached that these machines would not be able to meet the requirements needed for work upon the tunnel, the attention of the Commissioners was called to a new power-drill, which appeared to be free from the objections which had disclosed themselves in the one then in use.

As this drill could readily be adjusted to a carriage which had been prepared at great cost, and as its trial would involve no further expensive outlay for other necessary appliances, these having been already provided, it was though advisable to continue the organization for working by machinery for a few weeks longer, until the value of this system could be thoroughly ascertained.

Four drills of the new pattern have recently been brought into use, with flattering indications of success ; but until eight or ten can be kept steadily at work in one of the headings, it will be unwise to promise ourselves that every difficulty in this direction has been surmounted.

The adoption of machinery necessarily leads to the employment of a more skilful class of labor, and the saving is likely to be in time only, which may lessen the accumulation of interest on the great outlay required for the prosecution of the work.

The value and economy of nitro-glycerin as an explosive seems to have been fully demonstrated, and the method of using it with safety to the employees appears to be the only question now undetermined. Its early introduction is very desirable, and preparations are making to bring this about whenever it shall appear to be prudent to do so, since it is believed, on the strength of numerous experiments made in the tunnel at the West End, that by the use of this agent alone, as compared with gunpowder, the time required for completing the work may be greatly reduced.

Inquiries regarding the value of other substances used in blasting have been made, and it is not improbable that something may be provided as effective as glycerin, without its attendant dangers.

The system of exploding simultaneously by the agency of electricity appears to possess many advantages, and provision has recently been made for its early adoption upon every section of the work.

In order to produce rapid progress we are not necessarily dependent upon the use of power-drills, which, while they may give great promise of usefulness, are also liable to bring disappointment by the development of some hidden difficulty.

Various opinions are entertained regarding the expense to be incurred and the time consumed in completing the tunnel, and it may not be unwise to estimate these matters in what seems to us their most discouraging aspect.

It appears to be quite certain that, with the usual instrumentalities which have been furnished during the last three years, and without any aid from the Central Shaft, at headings from the two ends alone, 125 feet per month, or 1,500 feet per year, can be gained. This rate has been accomplished during several months of the present year. The distance between the two points is 18,000 feet, and to overcome that would, at the above rate, require just twelve years. The western section can be completed many years earlier, and this when done will effectually provide for the troublesome influx of water which is likely at times to retard operations from the West Shaft. The use of power-drills and newly invented explosives may very much reduce this period, or compensate at least for such occasional delays as will occur; while persons of practical and intelligent minds believe that, by the employment of nitroglycerin, simply as an auxiliary to hand labor, this estimated time may be shortened one-half.

Of the cost, it can be stated that, in the decomposed formation at the West End, a brick and stone tunnel is now being built, for a portion of the distance by contract, at \$400 per lineal foot. It is known that this formation does not extend beyond 1,900 feet, and there is good evidence tending to prove that it will hardly reach one-half this distance. The outlay for the whole of this section, then, need not exceed \$760,000. The distance between the heading at the East End and the heading at the West End is 18,000 feet. This heading comprises 60,000 cubic yards, which it is confidently believed can be taken out for less than \$15.00 per yard, or \$900,000. There would then remain of enlargement, on the present plan, and this may be somewhat reduced, 300,000 cubic yards, which could be let out at the present time at \$6.00 per yard, or \$1,800,000. From the West End to a connection at North Adams with that part of the railway now in operation, the construction of the road, land damages, and enlargement of the small tunnel at that point, should not exceed the sum of \$150,000. This shows that the entire amount necessary to be expended hereafter, without

interest, might reach the sum of \$3,610,000, in the present currency of the country, with a strong probability that the amount would be greatly lessened by an improved condition of the finances, and its consequent effect upon the prices of labor and materials. The present section of the tunnel, containing $18\frac{4}{10}$ cubic yards for each lineal foot, is one of very convenient form; but its usefulness could not be seriously impaired should it be made to contain but 17 yards, the difference being, at \$6.00 per yard, nearly \$200,000.

These estimates are not based upon any prices heretofore paid for work upon the tunnel.

From the best information to be obtained, the cost of taking out the heading, under the system pursued for three years past, cannot have been less than \$30 per cubic yard; and yet we have become satisfied that individual enterprise can accomplish better results than those indicated by the above calculations. Other work of a character quite as difficult has been performed at even lower rates.

Of the amount expended since the appointment of Commissioners in 1862 to Nov. 1, 1866, \$957,899.75 have been disposed of in the erection of a dam, wheel-house, and other buildings; in the purchase of land and machinery; in payments to engineers and for excavations at the west approach; leaving, for operations upon the rock in the tunnel and shaft, \$525,073.45. For this latter sum, 21,000 cubic yards have been removed, at an average cost of \$25 per yard.

For the first-named objects, large appropriations will not be requisite hereafter; and in the future management of the enterprise expenditures may be confined to the most expeditious and economical means of reducing the distance yet remaining to overcome.

The Sand Patch Tunnel, on the Pittsburg and Connelville Railroad, through one of the Alleghany Mountains, 18 by 16 feet, about a mile in length, a large portion built during the present year, the heading nearly complete, composed of very hard sandstone, lying more unfavorably for blasting and quite as hard to drill, as the rock of the Hoosac, has thus far cost but \$4.16 per cubic yard, including heading. Other tunnels, of

smaller dimensions; have been made at rates as low as this, and it is reasonable to assume that the work we are engaged in can be performed by the aid of private enterprise at a price within the estimates herein presented.

The Central Shaft is located between the two spurs of the mountain; its position has been determined by repeated observations. Until it reaches grade no engineering beyond the use of the plummet appears to be required, and the work upon it may be contracted for with no greater objection than would exist if it were situated in any other town in the State.

The East End is equally independent of other sections of the work; is thus far free from water or other obstructions, and may be pursued with hammer and drill and powder, so long as the line and the level are furnished to the miner.

At the West Shaft greater difficulties present themselves, and practical engineering skill is requisite; but should the State relieve the miner from the delays and expense which are incident to the influx of water, a favorable contract might be made for completing large portions of this section of the tunnel.

At the extreme west end, the work, under private supervision, is progressing satisfactorily, and while heretofore this seemed to be environed with insurmountable obstacles, beyond the ability of public servants to overcome, an individual contractor has, by his energy, determination and skill, been able to furnish the best evidence of ultimate success.

Under the law of 1863, the Commissioners can make no contract exceeding \$10,000 in amount, but the statute enacted in May last provides that the governor and council shall have the general supervision of the work, and as we believe that its most economical and speedy completion can be more certainly assured by inviting competition, and that better results in other respects are likely to follow, we recommend that the manner of conducting it be changed, and that the Commissioners be directed to contract the different sections of the work to competent parties, having due regard to the present financial condition of the country, and the prospect of more favorable terms prevailing in the future.

Whatever plan may be agreed upon, in order to continue work both upon the railroad and the tunnel throughout another year, a further appropriation will become necessary.

It is neither our duty or desire to comment on the antecedent history of this enterprise, but if, in the progress of the work, mistakes have been made, or unnecessary expenditures permitted, it will be borne in mind that these have occurred during an unsettled period of our national affairs, when the most extravagant prices were demanded, exaggerating even the errors which seem to be incident to the execution of every important undertaking.

The illness of Mr. Brooks, the former Chairman of the Commission, since May last, his resignation and that of his associate, Mr. Holmes, in August, and the prior resignation of Mr. Felton, having placed the work in the hands of the undersigned, they have aimed only at furnishing such information regarding its present condition as a limited connection with its management enables them to do, fully impressed with the belief that numerous costly arrangements for a systematic and vigorous prosecution of the work being already provided, under proper direction a removal of the barrier now existing between the two ends of the Hoosac Tunnel is no uncertain problem.

JAMES M. SHUTE,
ALVAH CROCKER,
CHARLES HUDSON,
Commissioners.

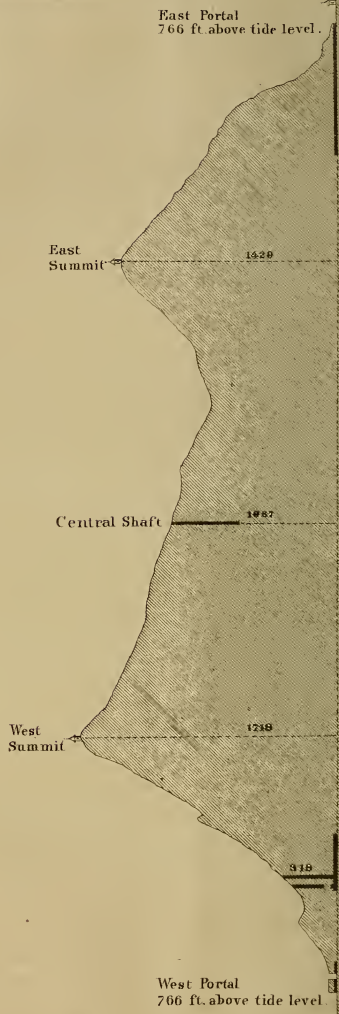
BOSTON, December 26, 1866.

DIAGRAM N° 4.

PROFILE
OF
HOOSAC MOUNTAIN.

Hor. Scale 4000 feet to 1 inch.
Ver. " 1000 " " "

Length of Hoosac Tunnel when finished	23,586.0 feet
Dec ^r 1, 1866 E. End heading	3473.0.
" " E. heading W. Shaft	1042.0.
" " W. " "	298.0.
" " W. End heading	1010.0
Balance	5823.0
Depth of Central Shaft when finished	19763.0
Dec ^r 1 st 1866 down	1037.0. ⁴ / ₁₆
Balance	3772. " "
	659.8. " "



REPORT OF THE CHIEF ENGINEER.

NORTH ADAMS, Dec. 19, 1866.

To the Commissioners of the Troy and Greenfield Railroad and Hoosac Tunnel, JAMES M. SHUTE, ALVAH CROCKER, and CHARLES HUDSON, this Report, concerning the progress upon the Hoosac Tunnel for one year subsequent to the time covered by my report dated Dec. 15, 1866, is respectfully submitted.

As all the members of the Commission under its original organization have left the Board, and as from this Board I received the appointment of Chief Engineer, it seems fit that I should here thank them for the generous support and kindly feeling extended to me during a period of nearly three years.

Having said to you that some other person might be your choice as Chief Engineer, you were kind enough to reply that you desired me to retain the position.

Hoping that this relationship may not be less pleasant than the former one, and that under your direction this great work may be economically and expeditiously carried on, I proceed to the details of my Report.

LINE.

Within the last year two more of the stone instrumental station-houses have been put up ; one at the East End, near the Portal, and another upon the mountain west of the Tunnel. This last is upon private ground, by permission of the owners, Messrs. L. L. Brown & Co., of South Adams.

The transit instruments referred to heretofore have been completed by J. H. Temple, of Boston, and by means of them

the line has been again worked up, until it is believed to be sufficiently near, over ground, for all practical purposes.

Upon the completion of the Tunnel to the West Shaft, it will probably be necessary to erect another station at the West End, just outside the Portal.

As this event is distant some years, and as the base line available at the foot of the West Shaft is less than eight feet long, it was foreseen a year ago that some provision must be made for a longer base by means of which the line could be run both east and west more accurately. It was therefore determined last December to sink a new shaft at a point 264 feet west of the West Shaft, and the work was at once entered upon. As the penetration east will probably be 4,000 feet before the West End work reaches that from the West Shaft, the necessity for this is made apparent.

Under the head of Supplementary Shaft the reasons will be given why a shaft was chosen rather than a boring, and a statement made of progress in sinking it.

LOCATION AND RIGHT OF WAY.

The location of the Tunnel has been made, and it is now possible to report that a right of way not less than five rods wide has been secured through its whole length, in part by the purchase of farms.

LABOR.

This has been, as heretofore, under the more especial charge of Mr. Hill.

A good Providence has watched over the health of our men, and has vouchsafed total exemption from accidental injuries.

Contentment and consequent order and quiet have prevailed. Wages remain as reported last year; viz., in the various headings and down the Central Shaft, \$2.25 per day of eight hours, and outside, \$1.50 for ten hours.

The system of statistical information concerning labor performed and material used has been kept up, it is believed, with advantage to the work. In addition to their previous duties, the statisticians have learned and practised, as far as material has been provided, the simultaneous firing of both powder and nitro-glycerin charges.

The system of store-keeping as originally established has been maintained, and the following table gives the monthly collections for supplies at the various stores.

Amounts collected Monthly for Supplies during the Year, from November 1, 1865, to November 1, 1866.

DATE.	East End.	Central Shaft.	West End.
November, 1865, . . .	\$3,287 66	\$707 90	\$3,088 42
December, 1865, . . .	2,191 63	798 39	3,118 13
January, 1866, . . .	2,051 17	798 54	3,001 42
February, 1866, . . .	1,901 87	587 43	3,725 51
March, 1866, . . .	1,941 31	553 73	4,174 11
April, 1866, . . .	1,811 51	547 75	4,218 16
May, 1866, . . .	2,042 23	545 17	4,542 62
June, 1866, . . .	2,343 22	740 00	4,822 57
July, 1866, . . .	2,084 33	598 85	5,166 67
August, 1866, . . .	2,069 86	787 04	5,130 30
September, 1866, . . .	1,941 28	919 02	5,031 84
October, 1866, . . .	1,887 96	1,040 38	4,782 48
	\$25,554 03	\$8,624 20	\$50,802 23
			8,624 20
			25,554 03
Total amount, . . .			\$84,980 46

There have been tenements erected during the past year as follows :

At the West End one has been put up for the accommodation of the brickyard men.

At the West Shaft, eight for the miners, one for the blacksmith, and a double cottage for the captain.

At the Central Shaft, two tenements have been built for the miners.

At the East End, a cottage has been put up for the resident engineer at that place, and a tenement for one of the mechanics

Under the contract made by the Commission with B. N. Farren, and dated May 1, 1866, he was to have such tenements

at the West End as he needed, and by his right he has, among other buildings, taken fifteen tenements there.

This made it necessary to put up at the West Shaft the eight for men who had before occupied those taken by Mr. Farren.

The following table shows the monthly collections of rents at the various parts of the work for one year.

Amounts collected Monthly for Rents during the Year, from November 1, 1865, to November 1, 1866.

DATE.	East End.	Central Shaft.	West End and West Shaft.
November, 1865, . . .	\$177 43	\$39 00	\$128 50
December, 1865, . . .	144 02	39 00	124 50
January, 1866, . . .	135 50	41 84	192 32
February, 1866, . . .	136 50	43 00	144 27
March, 1866, . . .	132 00	43 00	176 41
April, 1866, . . .	135 00	38 71	206 33
May, 1866, . . .	125 00	55 34	172 45
June, 1866, . . .	124 00	53 00	186 55
July, 1866, . . .	131 00	51 27	127 83
August, 1866, . . .	129 50	54 50	166 37
September, 1866, . . .	118 99	57 00	151 41
October, 1866, . . .	105 75	48 29	119 00
	\$1,594 69	\$563 95	\$1,895 94
			563 95
			1,594 69
Total amount,			\$4,054 58

By comparison with the building accounts, excluding the general one, it will be seen that the rents collected for dwellings, stores, &c., amount to $4\frac{84}{100}$ per cent. of the total cost of all buildings, including machine shops, shaft houses, barns, carpenter and blacksmith shops, powder houses, &c., for which no rent is received.

→ The dwellings probably pay an annual rent of about 10 per cent. on their cost.

The following table gives the various kinds of buildings, their numbers, and, in general, the rents received for each:—

	East End.	Central Shaft	West Shaft.	West End.	Rent— Yearly Each.
Boarding-house, East End,	1	—	—	—	—
“ “ Central Shaft,	—	1	—	—	\$120 00
“ “ West Shaft,	—	—	1	—	72 00
“ “ West End,	—	—	—	1	150 00
Cottage, double,	1	—	1	—	150 00
“ single,	1	—	—	—	—
“ “	1	—	—	—	60 00
Mechanics' and Foremen's tenements, double,	—	4	3	—	72 00
“ “ “ “ single,	7	—	1	2	60 00
Laborers' 1st class, double,	17	7	8	26	48 00
“ “ single,	2	—	—	—	12 00
“ 2d class, double,	—	—	4	—	48 00
Old store, converted into lodgings,	1	—	—	—	72 00
Stores,	1	—	—	1	150 00
“	—	1	—	—	100 00
Barns,	2	1	—	—	—
“ in part rented to Farren,	—	—	—	1	50 00
Carpenters' shops,	1	1	—	—	—
Carpenter shops, in part rented to Farren,	—	—	—	1	60 00
Blacksmith shops,	1	1	1	—	—
“ “ in part rented to Farren,	—	—	—	1	25 00
Machine shops,	1	1	—	—	—
Saw-mills,	1	1	—	—	—
Offices and store-houses, engineers and supt.,	2	1	1	—	—
“ rented to Farren,	—	—	—	1	15 00
Powder houses,	2	1	1	1	—
Gate houses,	2	—	—	—	—
Iron sheds,	1	—	—	1	—
Coal sheds,	1	—	1	—	—
Wood sheds,	—	1	—	—	—

	East End.	Central Shaft.	West Shaft.	West End.	Yearly Rent— Each.
Shaft and engine-houses, last being temporary,	1	1	2	—	—
Brick-yard, kiln shed,	—	—	—	1	—
	47	22	24	37	—
				24	—
				22	—
				47	—
Engineer's office and barn, North Adams,				2	—
General freight house, North Adams,				1	\$150 00
Coal shed, North Adams,				1	75 00
W. End & W. Shaft fr'ght house, on side track P. & N. A. R. R.,				1	—
Instrumental houses,				4	—
				139	—

On the 31st of October, 1866, there were employed, 116 men at the East End, 83 men at the Central Shaft, 134 men at the West and Supplementary Shafts, 18 men about the brick-yard, and about 100 men at the West End, under B. N. Farren's contract, making a total in the State's employ of 351, and, including Mr. Farren's, 451.

P. W. Smith has acted as agent for purchasing supplies and materials during the year; and Warren Stetson, very much to your acceptance I believe, was cashier until October, when Henry C. Cunningham took his place, and assumed his duties with some others additional.

MACHINERY.

The three portable engines belonging to the State are still on hand.

The 14-horse engine has been used most of the year to assist in sinking the Supplementary Shaft.

The 10-horse engine has been used for a time at Well No. 4; and is now driving a 5-inch plunger pump at the Supplementary Shaft.

The 7-horse engine has been used during the summer at the wheelpits in pumping water and running a derrick, and has since, with a centrifugal pump, been hired out for a short time, and is now laid up.

Our two saw-mills, one driven by water-power at the East End, and the other by steam at the Central Shaft, have proved most useful and economical to the work.

The hoisting apparatus built for the Central Shaft at the Lowell Machine Shop, has been set up and is working finely. In connection with this there is an air compressor of two cylinders, made by James Hunter and Son, similar to those at the East End, of thirteen inches in diameter and twenty inches stroke, but set vertically, all ready for work, either in driving drilling machines or in ventilating.

At the West Shaft another air compressor of four cylinders, of similar size and setting, has been for some time nearly ready for power or ventilation.

The air compressor of four horizontal cylinders, thirteen inches by twenty inches each, referred to in my former report, as about ready for use at the East End, has been at work day and night without cessation, except on Sundays, since March. It was intended to compress air to sixty pounds per square inch, and has run it up as high as eighty-five pounds; but as the drilling machines require air at only about thirty pounds pressure, it has generally been run at that pressure. It was intended for a speed of one hundred and twenty revolutions per minute; but as it can easily supply all our drilling machines, nine having been the highest number, at a speed of seventy revolutions, it has not usually been run faster.

This compressor, making seventy revolutions, will furnish 148.01 cubic feet of air per minute, at a pressure of forty-two pounds.

Another air compressor of four horizontal cylinders, twenty-five inches diameter by 24-inch stroke, has been set up at the East End. This is intended simply for ventilation, and will probably not be run at a higher pressure than five pounds per square inch. Making eighty revolutions per minute, it will furnish 2,181.3 cubic feet of free air per minute, which will fill 24.23 feet of heading or 4.39 feet of full size tunnel per minute.

It is now being run about two hours after each blasting, and furnishes all the ventilation necessary for the present.

In addition to a small air compressor of three cylinders of 8-inch by 12-inch stroke which has been on hand some time, we now have two other similar ones made by Harrison Loring, intended for special use in case the local ones break down. These can easily be transported from place to place, and be run by belts, in readiness for this purpose.

In addition to the tools mentioned in my last report, we have since procured of the Putnam Machine Company a larger engine-lathe, and a hand-lathe; both of which, with the others, are in constant use.

I have advised to put into the Supplementary Shaft two bull engines, having steam cylinders of thirty inches diameter, plungers of thirteen inches diameter, and a stroke of ten feet for both piston and plunger.

This is the most economical engine for pumping, and being regulated in the frequency of its strokes by a cataract, it can be exactly adjusted to the variable and increasing quantity of water. This is not true of any other engine adapted to this work, as if too large for present purposes it will waste fuel, and if too small for future requirements, it must be replaced by larger.

Messrs. H. G. Burgess and John Christiansen have most acceptably filled the respective positions of master mechanic and mechanical draughtsman, and the satisfactory working of this department has been in a great degree due to their ability and watchfulness.

DRILLING MACHINES.

An automatic machine able to do the drilling necessary in driving the Tunnel, at a saving in cost and time over the manual system which requires such hard and persistent labor, and which if it could be found would be the key to the whole system of progress and economy in tunnelling, has been most assiduously sought.

The point was early decided that such machines must be pneumatic, as it was found to be utterly impracticable to run them in headings far beneath ground, by steam.

The former Chairman of the Board gave himself especially to this problem, and with the help of mechanics, devised and brought out a machine, of which from thirty to forty were introduced into the East End heading in June last, and which have done all the work reported upon in the tables of machine work. They were beautiful machines, light in weight, compact in form, and automatic, but proved themselves in a few days to be deficient in the very necessary quality of strength. As I learn from the foreman of the East End shop, Mr. William Hall, they are made up of eighty parts and weigh about 240 pounds each. They cost about \$400 apiece.

It is not agreed among mechanics whether they can be made sufficiently strong to become an economical tool. Our mechanical draughtsman has made a suggestion to this end which is quite worthy to be followed out.

The progress made has been with from one to nine machines, probably an average of three machines, working through the time given to drilling.

There have been 979 of these machines sent out of the heading for repairs, and the following table gives the principal parts which have failed.

Table showing the Number of Principal Parts of Drilling Machines broken, up to Nov. 1, 1866.

Crossheads,	59
Cylinder flangs,	18
Coupling nuts,	28
Feed nuts,	39
Feed springs,	415
Feed palls,	90
Ratchet covers,	163
Screw spindles,	19
Shields,	14
Tappet bars,	120
Union coupling nuts,	26
Valve stems,	27

It will be seen that the breakages are confined prominently to two parts, one of which is a simple and inexpensive spring.

Had a sufficiently large number of machines been provided, so that twelve had been constantly in order for use, as was intended, it cannot be doubted that a progress which with three machines almost reached that made by hand, would have been very much increased. But, under the existing circumstances, machine drilling has been prejudicial to progress and very expensive.

An improvement upon the first machine, perhaps indeed a new machine, has been invented by a member of the Putnam Machine Co., C. Burleigh, and several of them have been introduced into the heading since Nov. 1, 1866. It is made up of the same number of parts as the first machine, is inferior to the first in compactness, weighs 372 pounds, and is not practically automatic as yet.

It has not been long enough at work to test its qualities. The two machines drill at about the same rate, but the second one is likely to prove much more durable than the first.

While the reports of East End progress and cost are unfavorable in regard to the use of machine drills as heretofore constituted, and far from satisfactory to those who invented them, and perhaps discouraging to many friends of the enterprise, who hoped by a successful machine to overthrow all reasonable opposition, it may still, I think, be expected that either the machine of Mr. Burleigh, now on trial, in which he expresses the utmost confidence, or some improvement upon it, will prove to be the thing sought for.

Of all the reciprocating machines brought to your notice, that of Mr. Burleigh seems to me most promising.

The annular diamond drill is also worthy to be considered as one which avoids the concussion consequent upon reciprocation, having itself a rotary movement, and being able to begin its boring without any previous preparation of the face of the rock.

I can but express the hope that so influential and wealthy a Commonwealth as Massachusetts, may justify you in a most liberal and enlarged policy in this respect, which shall give these and other machines an opportunity to be developed.

I think further experiments should not be made in the headings, nor with a great number of the same kind of machines,

which is unnecessarily expensive, but in a shop, and with single machines.

A large outlay, which should soon result in a machine able to run a month without a break, would doubtless be many times repaid to the State in the construction of the Tunnel, would advance the cause of science, and give a vigorous impulse to the internal improvement of the country. Great results are commonly reached step by step.

GENERAL ITEMS.

It has been my continual desire since entering upon this work to learn how to fire several charges at the same time. This I hoped to do of Colonel Tal. P. Schaffner, but his coming upon our work was so long delayed, it being something more than a year after his first brief visit here, that it began to seem hopeless. Last spring, in making a visit to the Bessemer steel-works in Troy, partly in way of business, but more out of curiosity to see and learn something concerning this process of making steel, it was my good fortune to obtain an introduction, through Mr. Holley of the steel-works, to J. J. Revy, of London. Mr. Revy is connected with the gun-cotton works of Loudon, and was acquainted with the most approved methods of simultaneous firing. He very kindly and fully explained to me the process, and gave me a description of the electrical machine and fuses necessary, and also afterwards made a visit to our Tunnel. The Commissioners ordered for me two electric machines, four thousand fuses, and several miles of conducting and connecting wire.

These were several months in transit, and before their arrival Colonel Schaffner came with his material. His machine for exploding was magneto-electrical, and by it and his system of connecting wires it was found impossible to fire more than about five charges at once, and these not simultaneously. This of course was far from satisfactory. Shortly after, the ebonite machines with the Abel fuses ordered for me arrived, and we very soon learned how to use them both, and have been able to fire at once as many as thirty-one charges.

While it is important to save the time which can be saved by this process in firing, and to reduce the risk of accident, and to avoid the smoke made by the burning of the common fuse,

it is much more important to the progress that *simultaneity* of firing be secured. If charges in adjoining holes can be fired as though but *one* charge, then they help each other and much more rock will be torn away. The whole top may be thrown down or the bottom brought up by proper arrangement of holes, and by means of a ring of converging holes, the centre may be dragged out. The passage of the electric spark through *one* system of wires occupies practically no appreciable time, while through several systems it may. If the charges in adjoining holes are fired with the interval of an instant, it may just as well be a week as far as the tearing of the rock is concerned.

The number of fuses obtained was so small that their influence upon progress is hardly appreciable, except possibly at the Central Shaft.

Under the direction of Colonel Schaffner, experiments have been tried at the West Shaft with nitro-glycerin.

The article used was imported from Europe, and much time was consumed in ordering, shipping, and passing it through the custom house.

In these experiments Colonel Schaffner has been eminently successful. No accident has resulted, and indeed there seems to be comparatively little risk if the article is good and ordinary care is taken in its use.

The glycerin will occasion to some persons, if they are exposed to it in a particular manner, a headache for an hour or two, while others are not thus affected. Our men have made very little complaint in this respect, and indeed there has been no difficulty experienced in introducing this *new* and powerful explosive among men who never before have used anything but powder.

It was some time ago demonstrated by experiment, that *double* progress could be made with glycerin over that made with powder, at *less* cost. This is a wonderful achievement, and its effect upon the prospect of this work, in regard to its early completion, at reasonable cost, cannot but be good.

It is true that the experiment was limited to a shorter time by reason of the small supply of electrical fuses and glycerin than could have been wished, and that my views may upon further experience be modified or changed even, but with what infor-

mation I *now* have, there is no room to doubt its fitness for our purpose. It is the testimony of all who have seen our work, including Mr. Revy, George Berkley, of London, C. E., Dr. Ehrhardt, of London, Colonel Schaffner and others familiar with tunnelling, that while our rock is not in general harder to drill than many others, it is most persistently tough. That is, the number of charges we fire, if they could be in granite, or lime, or in any brittle stone, would bring out two or three times more of debris than now. It is therefore necessary that we should have the quickest explosive to get the best result. As preparations of mercury are not to be thought of on account of their danger, we take glycerin as being next to them in power, while it is *comparatively* safe. Whenever its extensive use shall be concluded upon, it will be necessary to secure the services of some scientific person expert in handling it, that some antidote against headache may be discovered, and that the risk may be reduced to the lowest possible point.

Bulk for bulk, which is the only useful comparison to be made here, nitro-glycerin is eight times more powerful than common powder.

During the year my assistants have been William P. Granger, resident at West End and West Shaft, F. W. D. Holbrook at the East End, and W. G. Coolidge at the Central Shaft; and I wish here to express my satisfaction with the manner in which they have performed their duties and my belief in their ability and faithfulness. It is only *through* them that I am able to have the whole work under my eye all the time, and only *by* them is it possible to try the various experiments necessary in the progress of the work, and only *from* them can I get the monthly estimates from the different parts of the work, which will enable me to judge whether any part of the work is less rapidly or economically pushed than any other.

They also act as checks upon the lines and grades of each other, which they are sometimes required to examine, and in which there is great chance for error.

DIVISION OF THE WORK.

As heretofore the different parts of the work are known under the five different names of Deerfield Dam, East End, Central Shaft, West Shaft and West End.

Under West Shaft there will be the subdivision of Supplementary Shaft, and under West End that of Brickyard.

DEERFIELD DAM AND WATER-POWER.

The following is a table giving the amount of water over the crest of the dam, measured twice a day for the year, so far as it has been practicable to do so.

1865.	FEET.		1865.	FEET.	
	A. M.	P. M.		A. M.	P. M.
November 1, . . .	2.17	1.67	December 11, . . .	0.64	0.60
" 2, . . .	1.24	1.09	" 12, . . .	0.59	0.62
" 3, . . .	2.34	1.72	" 13, . . .	0.99	1.70
" 4, . . .	1.24	1.24	" 14, . . .	1.32	1.20
" 5, . . .	2.67	2.24	" 15, . . .	0.74	0.66
" 6, . . .	1.41	1.32	" 16, . . .	0.47	0.51
" 7, . . .	1.08	0.86	" 17, . . .	0.42	0.42
" 8, . . .	0.70	0.78	" 18, . . .	0.39	0.30
" 9, . . .	0.66	0.62	" 19, . . .	0.36	0.45
" 10, . . .	0.60	0.54	" 20, . . .	0.57	0.47
" 11, . . .	0.45	0.43	" 21, . . .	0.36	0.39
" 12, . . .	0.41	0.40	" 22, . . .	0.44	0.47
" 13, . . .	0.44	0.46	" 23, . . .	0.55	0.58
" 14, . . .	0.48	0.47	" 24, . . .	0.65	0.72
" 15, . . .	0.50	0.49	" 25, . . .	0.75	0.78
" 16, . . .	0.53	0.55	" 26, . . .	0.73	0.74
" 17, . . .	0.80	0.80	" 27, . . .	0.75	3.10
" 18, . . .	0.79	0.75	" 28, . . .	1.38	1.36
" 19, . . .	0.69	0.75	" 29, . . .	1.00	0.93
" 20, . . .	0.75	0.77	" 30, . . .	0.80	0.65
" 21, . . .	0.69	0.70	" 31, . . .	0.60	0.58
" 22, . . .	1.32	1.49	1866.		
" 23, . . .	1.32	1.19	January 1, . . .	0.54	0.55
" 24, . . .	0.95	0.95	" 2, . . .	0.50	0.46
" 25, . . .	0.85	0.82	" 3, . . .	0.42	0.44
" 26, . . .	0.78	0.74	" 4, . . .	0.40	0.38
" 27, . . .	0.70	0.70	" 5, . . .	0.33	0.32
" 28, . . .	0.70	0.66	" 6, . . .	0.50	0.60
" 29, . . .	0.49	0.47	" 31, . . .	-	0.50
" 30, . . .	0.52	0.60	February 1, . . .	0.50	0.47
December 1, . . .	0.62	0.63	" 2, . . .	0.47	0.48
" 2, . . .	0.51	0.52	" 3, . . .	0.50	0.48
" 3, . . .	0.56	0.56	" 4, . . .	0.60	0.52
" 4, . . .	0.55	0.89	" 5, . . .	0.55	0.52
" 5, . . .	1.34	1.99	" 6, . . .	0.72	0.67
" 6, . . .	1.19	1.03	" 7, . . .	0.90	0.40
" 7, . . .	0.76	0.72	" 8, . . .	0.40	0.30
" 8, . . .	0.56	0.52	" 9, . . .	0.35	0.34
" 9, . . .	0.42	0.48	" 10, . . .	0.40	0.35
" 10, . . .	0.62	0.62			

1866.		FEET.		1866.		FEET.	
		A. M.	P. M.			A. M.	P. M.
February	11, . .	0.40	0.38	April	4, . .	—	—
"	12, . .	0.52	1.30	"	5, . .	1.30	2.60
"	13, . .	2.20	1.70	"	6, . .	2.00	2.50
"	14, . .	1.10	0.90	"	7, . .	2.40	1.65
"	15, . .	0.85	0.80	"	8, . .	1.30	1.30
"	16, . .	0.60	0.80	"	9, . .	1.25	1.30
"	17, . .	0.60	1.10	"	10, . .	1.00	0.75
"	18, . .	0.50	0.70	"	11, . .	0.70	0.80
"	19, . .	0.50	1.90	"	12, . .	0.90	1.00
"	20, . .	1.90	1.70	"	13, . .	1.40	1.40
"	21, . .	1.30	0.80	"	14, . .	1.85	1.70
"	22, . .	0.90	1.00	"	15, . .	2.40	2.10
"	23, . .	1.05	0.90	"	16, . .	1.80	1.50
"	24, . .	1.20	2.60	"	17, . .	1.30	1.10
"	25, . .	3.10	2.20	"	18, . .	1.10	1.00
"	26, . .	1.20	1.20	"	19, . .	1.30	1.40
"	27, . .	1.05	1.00	"	20, . .	1.50	1.58
"	28, . .	0.85	0.85	"	21, . .	1.48	1.52
March	1, . .	0.70	0.65	"	22, . .	1.30	1.32
"	2, . .	0.60	0.60	"	23, . .	1.18	1.20
"	3, . .	0.70	0.67	"	24, . .	2.12	2.20
"	4, . .	0.60	0.60	"	25, . .	1.55	1.30
"	5, . .	0.50	0.45	"	26, . .	1.20	0.95
"	6, . .	0.50	0.20	"	27, . .	0.85	0.80
"	7, . .	0.15	0.40	"	28, . .	0.70	0.70
"	8, . .	0.45	0.55	"	29, . .	0.70	0.70
"	9, . .	0.40	0.50	"	30, . .	0.68	0.65
"	10, . .	0.60	0.50	May	1, . .	0.60	0.58
"	11, . .	0.50	0.40	"	2, . .	0.55	0.60
"	12, . .	0.40	0.40	"	3, . .	0.57	0.55
"	13, . .	0.90	1.00	"	4, . .	0.52	0.48
"	14, . .	1.20	1.05	"	5, . .	0.48	0.47
"	15, . .	1.10	2.05	"	6, . .	0.42	0.40
"	16, . .	2.20	2.50	"	7, . .	0.40	0.40
"	17, . .	1.80	1.50	"	8, . .	0.37	0.32
"	18, . .	1.00	1.00	"	9, . .	0.31	0.38
"	19, . .	0.80	0.80	"	10, . .	0.51	0.43
"	20, . .	0.60	0.70	"	11, . .	0.43	0.43
"	21, . .	0.75	0.70	"	12, . .	0.41	0.39
"	22, . .	0.60	0.75	"	13, . .	0.37	0.34
"	23, . .	0.50	0.65	"	14, . .	0.70	0.97
"	24, . .	0.60	0.62	"	15, . .	0.72	0.67
"	25, . .	0.50	0.55	"	16, . .	0.57	0.52
"	26, . .	0.45	0.70	"	17, . .	0.72	0.68
"	27, . .	0.90	0.70	"	18, . .	0.62	0.58
"	28, . .	0.60	0.60	"	19, . .	0.52	0.51
"	29, . .	0.70	0.65	"	20, . .	0.47	0.43
"	30, . .	0.55	0.60	"	21, . .	0.40	0.39
"	31, . .	0.65	0.55	"	22, . .	0.36	0.34
April,	1, . .	0.67	0.75	"	23, . .	0.33	0.37
"	2, . .	0.90	0.74	"	24, . .	0.33	0.20
"	3, . .	0.65	0.70	"	25, . .	0.28	0.31

1866.		FEET.		1866.		FEET.	
		A. M.	P. M.			A. M.	P. M.
May	26, . .	0.31	0.31	July	17, . .	0.10	0.25
"	27, . .	0.28	0.36	"	18, . .	0.90	0.95
"	28, . .	2.32	2.12	"	19, . .	1.10	1.00
"	29, . .	1.81	1.38	"	20, . .	1.00	1.00
"	30, . .	0.98	0.90	"	21, . .	0.95	0.85
"	31, . .	0.90	0.90	"	22, . .	1.00	1.00
June	1, . .	0.80	0.71	"	23, . .	1.00	1.45
"	2, . .	0.67	0.59	"	24, . .	1.50	1.45
"	3, . .	0.57	0.53	"	25, . .	1.30	1.05
"	4, . .	0.59	1.05	"	26, . .	1.00	0.95
"	5, . .	0.98	0.88	"	27, . .	0.85	0.55
"	6, . .	0.83	0.84	"	28, . .	0.78	0.95
"	7, . .	1.70	1.47	"	29, . .	1.00	1.00
"	8, . .	1.19	1.03	"	30, . .	0.90	0.90
"	9, . .	0.85	0.83	"	31, . .	0.90	0.80
"	10, . .	0.67	0.62	August	1, . .	0.95	0.70
"	11, . .	0.60	0.56	"	2, . .	0.90	0.75
"	12, . .	0.51	0.48	"	3, . .	0.98	0.70
"	13, . .	0.41	0.40	"	4, . .	0.90	0.80
"	14, . .	0.75	0.68	"	5, . .	1.00	0.95
"	15, . .	0.79	0.69	"	6, . .	0.95	1.00
"	16, . .	0.55	0.49	"	7, . .	1.00	1.10
"	17, . .	0.46	0.43	"	8, . .	1.00	0.95
"	18, . .	1.18	2.07	"	9, . .	1.00	0.95
"	19, . .	1.53	1.19	"	10, . .	1.50	1.40
"	20, . .	0.90	0.79	"	11, . .	1.25	1.20
"	21, . .	0.61	0.59	"	12, . .	1.10	1.05
"	22, . .	0.48	0.51	"	13, . .	1.00	0.95
"	23, . .	0.63	0.57	"	14, . .	0.95	0.95
"	24, . .	0.48	0.45	"	15, . .	0.95	1.40
"	25, . .	0.36	0.36	"	16, . .	1.65	1.50
"	26, . .	0.27	0.30	"	17, . .	1.25	1.70
"	27, . .	0.20	0.27	"	18, . .	1.10	1.00
"	28, . .	1.10	0.90	"	19, . .	1.00	1.00
"	29, . .	0.60	0.54	"	20, . .	1.50	1.10
"	30, . .	0.40	0.46	"	21, . .	1.20	1.10
July	1, . .	0.48	0.46	"	22, . .	1.10	0.90
"	2, . .	0.39	0.28	"	23, . .	1.05	0.90
"	3, . .	0.25	0.22	"	24, . .	1.10	1.10
"	4, . .	0.22	0.20	"	25, . .	1.05	0.95
"	5, . .	0.20	0.49	"	26, . .	0.95	0.90
"	6, . .	0.38	0.33	"	27, . .	1.05	0.80
"	7, . .	0.24	0.20	"	28, . .	0.95	0.80
"	8, . .	0.22	0.22	"	29, . .	0.95	0.80
"	9, . .	0.37	0.62	"	30, . .	0.82	0.70
"	10, . .	0.40	0.37	"	31, . .	0.92	0.78
"	11, . .	0.28	0.23	September	1, . .	0.75	0.62
"	12, . .	0.20	0.14	"	2, . .	0.85	0.85
"	13, . .	0.18	0.05	"	3, . .	0.60	0.45
"	14, . .	0.11	0.08	"	4, . .	1.00	0.98
"	15, . .	0.15	0.15	"	5, . .	0.92	1.00
"	16, . .	0.04	-	"	6, . .	1.00	1.00

1866.	FEET.		1866.	FEET.	
	A. M.	P. M.		A. M.	P. M.
September 7, . .	1.00	1.00	October 5, . .	0.21	0.20
" 8, . .	0.80	1.00	" 6, . .	0.19	0.17
" 9, . .	0.20	0.20	" 7, . .	0.25	0.22
" 10, . .	0.10	0.10	" 8, . .	0.18	0.21
" 11, . .	0.10	0.20	" 9, . .	—	—
" 12, . .	1.00	1.60	" 10, . .	—	—
" 13, . .	1.60	1.00	" 11, . .	—	—
" 14, . .	0.80	0.80	" 12, . .	0.25	0.20
" 15, . .	0.80	0.70	" 13, . .	0.20	0.15
" 16, . .	0.70	0.50	" 14, . .	0.25	0.25
" 17, . .	0.40	0.40	" 15, . .	0.25	0.20
" 18, . .	0.50	0.70	" 16, . .	0.40	0.20
" 19, . .	0.90	1.00	" 17, . .	0.10	0.20
" 20, . .	1.40	1.00	" 18, . .	0.20	0.20
" 21, . .	1.10	1.30	" 19, . .	0.20	0.17
" 22, . .	2.83	1.40	" 20, . .	0.25	0.17
" 23, . .	1.40	1.10	" 21, . .	0.25	0.25
" 24, . .	0.85	0.80	" 22, . .	0.13	0.13
" 25, . .	0.60	0.60	" 23, . .	0.17	0.15
" 26, . .	0.50	0.50	" 24, . .	0.15	0.13
" 27, . .	0.82	0.95	" 25, . .	0.13	0.13
" 28, . .	0.80	0.60	" 26, . .	0.17	0.14
" 29, . .	0.40	0.50	" 27, . .	0.16	0.16
" 30, . .	0.50	0.45	" 28, . .	0.25	0.25
October 1, . .	0.38	0.32	" 29, . .	0.25	0.25
" 2, . .	0.32	0.32	" 30, . .	1.20	8.30
" 3, . .	0.28	0.25	" 31, . .	3.00	2.00
" 4, . .	0.25	0.20			

From July 18 to September 9, temporary and leaky flash-boards, nine inches in height, were on the crest of the dam.

October 9th, 10th and 11th, the pond above the dam was drawn down in order to plank worn places in lower aprons.

The following is a table of rain-fall at the East End :—

January,	2.206 inches.
February,	4.409 "
March,	3.000 "
April,	2.129 "
May,	4.009 "
June,	6.110 "
July,	4.713 "
August,	4.895 "
September,	4.460 "
October,	4.932 "

The dam has through the year safely permitted the passage of the river, including the ice freshets of December 27, of 7 feet, and February 24, of 6 feet, and the water freshets of October 30, of $8\frac{8}{10}$ feet, and that of November 16, of 6 feet, which are the principal ones.

The canal, which had during the previous year been somewhat leaky through the coarse diluvial soil of its banks and bed, has now become so tight as to compare favorably with the best canals in New England.

Houses have been built over the head-gates, and the waste-gates and overflow, to prevent the forming of ice about them, and to protect them from mischief-makers.

The masonry of the wheel-house has been extended only so far as necessary to cover the third wheel-pit, before done, and such machinery as might be connected with it, and to permit the moving forward of the canal bulkhead so far as to allow the water to pass to the third wheel.

It has been said that the cost of the wheel-house has been much more than it should have been.

It having been determined to build it, I think its cost can be shown to be not greater than necessary.

The house was located in the only place where it would not be necessary to cut the whole width of the house and canal into a very high bank. It was at the foot of an old, extensive slide.

Upon making the necessary excavations, it was found that the bottom was soft clay, and, very much to our alarm, that the bottom was rising, and that the avalanche was on the move. It therefore became necessary, in connection with the fact that the water-level of the canal back of the house was to be 30 feet higher than the river and front, to build *heavy* masonry. The back wall was made 17 feet thick at the bottom, the whole height of the wall being over 40 feet.

It should further be considered that it became necessary to build with the stone from the Tunnel, because none better could be reasonably obtained. The masonry is therefore simply a conglomerate of junks of stone; but, for want of a natural bond, it must have an artificial one, and this could only be obtained by the use of cement in large quantities, and at great cost, because so far from a railroad. The window and door-

jambes were made from such stone, at great cost for labor, while the caps and sills came from over the mountain.

The house has not moved, or it would indicate it in the derangement of the machinery at work therein.

EAST END.

Work here has only been interrupted by a refusal of the men to work from May 1 to May 8, because their demand for increase of pay was not complied with.

The progress made monthly in the heading is shown in the following table:—

DATE.						Distance from Portal.	Progress.
November 1, 1865,	.	.	.	.	.	2,839.0 feet.	
December 1, "	.	.	.	.	.	2,904.9 "	65.0 feet.
January 1, 1866,	.	.	.	.	.	2,950.5 "	46.5 "
February 1, "	.	.	.	.	.	3,005.0 "	54.5 "
March 1, "	.	.	.	.	.	3,052.0 "	47.0 "
April 1, "	.	.	.	.	.	3,115.0 "	63.0 "
May 1, "	.	.	.	.	.	3,176.5 "	61.5 "
June 1, "	.	.	.	.	.	3,227.0 "	50.5 "
June 8, "	.	.	.	.	.	3,239.5 "	12.5 "
<i>Changed from Hand to Machine Drilling.</i>							
June 14, 1866,	.	.	.	.	.	3,239.5 "	
July 1, "	.	.	.	.	.	3,253.5 "	14.0 "
August 1, "	.	.	.	.	.	3,301.5 "	48.0 "
September 1, "	.	.	.	.	.	3,356.0 "	54.5 "
October 1, "	.	.	.	.	.	3,394.5 "	38.5 "
November 1, "	.	.	.	.	.	3,431.0 "	36.5 "
Total progress for the year,							592.0 feet.

The heading was driven by manual labor until June 8, when it was suspended to prepare for introducing automatic pneumatic drills.

These began their work on the 14th of June. The heading enlargement has been carried to 2,566 feet west of Portal.

From November 1, 1865, to June 8, 1866, there were expended in the East End heading,—

Days of labor, including foreman,	.	.	.	5,476.05
Drills dulled,	.	.	.	112,489.
Inches of hole drilled,	.	.	.	255,769.
Holes made,	.	.	.	9,828.
Pounds of powder used,	.	.	.	6,563.
Feet of fuse used,	.	.	.	30,202.
Pounds of candles used,	.	.	.	2,605.75
Feet of progress made,	.	.	.	400.5
Cubic yards of rock removed,	.	.	.	1,517.3

This will give for one day's labor of one man,—

Drills dulled,	.	.	.	.	20.540
Inches of hole drilled,	.	.	.	.	46.703
Holes made,	.	.	.	.	1.795
Pounds of powder used,	.	.	.	.	1.198
Feet of fuse used,	.	.	.	.	5.515
Pounds of candles used,	.	.	.	.	0.476
Feet of progress made,	.	.	.	.	0.073
Cubic yards of rock removed,	.	.	.	.	0.277

Or one foot of advancement requires the expenditure of,—

Days' labor of one man,	.	.	.	.	13.674
Drills dulled,	.	.	.	.	280.871
Inches of hole,	.	.	.	.	638.624
Holes,	.	.	.	.	24.539
Pounds of powder,	.	.	.	.	16.387
Feet of fuse,	.	.	.	.	75.410
Pounds of candles,	.	.	.	.	6.506
Cubic yards of rock removed,	.	.	.	.	3.788

We also find that the holes have an average depth of 26.025 inches, that each drill-bit cuts 2.274 inches of hole, and that each hole consumes 0.66779 pounds of powder and 3.0730 feet of fuse. The holes are $1\frac{3}{8}$ inches in diameter.

From June 14, 1866, to November 1, 1866, there were expended, under the machine system, in the East End heading,—

Days of labor, including foremen,	4,350.05
Number of machines sent out,	979.
Drills dulled,	9,336.
Inches of hole drilled,	161,504.
Holes made,	5,229.
Pounds of powder used,	6,313.
Feet of fuse used,	21,951.
Pounds of candles used,	2,267.67
Feet of progress made,	191.5
Cubic yards of rock removed,	925.9

This will give for one day's labor of one man,—

Drilling machines broken down,	0.225
Drills dulled,	2.146
Inches of hole drilled	37.123
Holes made,	1.202
Pounds of powder used,	1.451
Feet of fuse used,	5.046
Pounds of candles used,	0.521
Feet of progress made,	0.044
Cubic yards of rock removed,	0.213

Or one foot of advancement requires the expenditure of,—

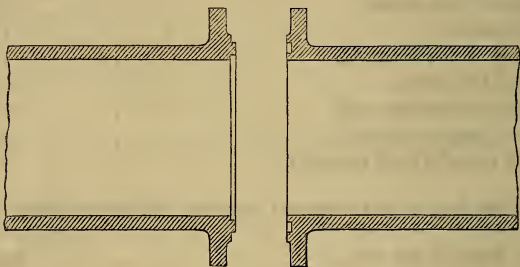
Days' labor of one man,	22.718
Number drilling machines working until broken,	5.112
Drills dulled,	48.752
Inches of hole,	843.363
Holes,	27.305
Pounds of powder	32.966
Feet of fuse,	114.626
Pounds of candles,	11.842
Cubic yards of rock removed,	4.835

We also deduce from the above that the holes have an average depth of 30.886 inches, that each drill-bit cuts 17.299

inches of hole, that each drilling machine, while in working order cut 164.968 inches of hole, or 5.341 holes, and that each hole consumes 1.207 pounds of powder and 4.178 feet of fuse. The holes are $1\frac{5}{8}$ to $1\frac{6}{8}$ inches in diameter and perfectly round.

The wooden culvert to contain the pipes and carry away the water has been laid as far as the heading enlargement will permit. From the wheel-house, the 8-inch iron pipe to convey the pneumatic power, and the 12-inch iron pipe for additional ventilating air, have been laid, also from the Portal the 3-inch iron pipe for water.

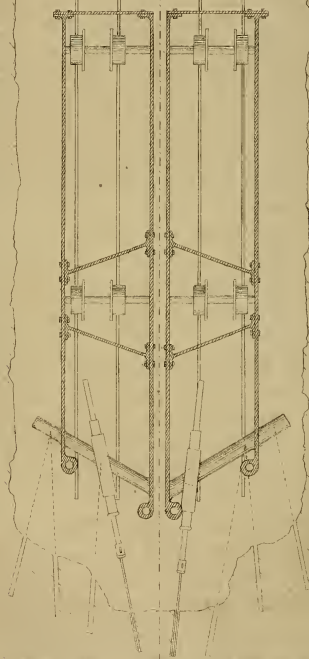
The joints in these various sized pipes are similarly made, there being a recess $\frac{3}{4}$ inch wide and $\frac{3}{16}$ inch deep, turned in one flange, while upon the other is turned a corresponding follower or projection. In this recess, and before the follower, is put a rubber packing-ring of pure gum, $\frac{3}{4}$ inch wide and $\frac{1}{8}$ inch thick. This makes a remarkably tight joint, and can be understood more easily by reference to the following diagram :—



The blacksmith's shop is near the line of air-pipes, and the fires in its forges are blown by air taken from the 8-inch pipe. The air from this pipe is also to be used for running a power hammer, now under construction by Lyman Kingsley.

Under the supposition that coal-gas was to be made outside the Tunnel for use in the heading, at the enlargement, in the blacksmith's shop and at the wheel-house, a gas-pipe has been laid in the Tunnel culvert with the other three pipes. But should the present experiment in the use of naphtha gas prove successful, it will be of no use.

DIAGRAM N° 1.



Scale 8 feet to 1 inch.

T. Doane.

When a heading is driven by hand, it is possible and usual to locate each hole in such a place, and drive it in such a direction, as will enable it to get the most rock. That is, the holes can be arranged to suit the form of the heading as left by the previous blast. The fact that machine labor cannot do this as well has been one great argument against its use.

To meet the above objection to machine drilling, there being nothing in the machine drills themselves to prevent it, the carriage spoken of in my last report was devised. Diagram No. 1 will explain its shape in plan as adapted to the form of the heading.

It is found in practice that a hole can be put in almost any place and direction by means of these machines and carriages. The carriages may not be perfect in every respect, but it is enough to say of them that they have met all the demands made upon them. They will hold a machine in place to drill a hole wherever wanted, for it has not been necessary to make a hand hole since the machines went in; they can be taken out beyond reach of the blasts, or brought in again in a few minutes by the men in the heading, and they have not in any respect shown a want of strength, nor has anything been spent in repairs upon them.

It will be seen by reference to the table, that with machine drilling, a progress about equal to that by hand drilling was very soon reached, and this was done by the old gangs, with the addition to each gang at first of two mechanics, now reduced to one.

This was when the machines were new, and when there was a larger supply on hand than there has since been, which must be our excuse for not maintaining greater progress. Had a sufficient supply of machines been provided, there can be little doubt that very much greater progress would have been attained.

The following table gives the average times occupied under the machine-drilling system in the various operations. The blasting has been done once in eight hours, and the averages are made up from data kept through the whole time.

1866.	Removing Rock.	Preparing to Drill.	Machines Drilling.	Loading and Blasting.
July, . . .	1 hr. 08 min.	0 hr. 32 min.	5 hr. 07 min.	1 hr. 13 min.
August, . .	1 08	0 30	5 06	1 16
September, . .	1 03	0 13	5 31	1 23
October, . .	0 54	0 10	5 57	0 59

Whenever the machines shall be able to make the necessary number of holes, so that blasting can advantageously be oftener done, a change will be made to blasting once in six hours, or to blasting twice in each shift.

CENTRAL SHAFT.

This part of the work has been continuously driven, except from the 6th of May to the 1st of August, when the new hoisting machinery was being put in place.

The following table gives progress in sinking during the year covered by this Report:—

DATE.	Distance Down.	Progress.
November 1, 1865,	200.8 feet.	—
December 1, 1866,	220.1 “	19.3 feet.
January 1, 1866,	232.5 “	12.4 “
February 1, “	250.7 “	18.2 “
March 1, “	264.0 “	13.3 “
April 1, “	280.9 “	16.9 “
May 1, “	297.1 “	16.2 “
May 6, “	300.5 “	3.4 “
Stopped to put in new hoisting apparatus, .	—	—
August 1, 1866,	300.5 “	—
September 1, “	311.9 “	11.4 “
October 1, “	331.1 “	19.2 “
November 1, “	354.0 “	22.9 “
Progress for the year,	—	153.2

From November 1, 1865 to October 6, 1866, the common fuse or slow match was used in firing the charges, and generally, out of eight or nine holes to a shift, one or two would be lost through the extinguishment of the lighting candle or the fuse. Since October 6, the Abel fuse has been used, and the firing is done by electricity from the office above ground, and it is very rare to lose a hole. This system relieves the men from all risk in firing the charges, which had come to be very considerable; they can at once return below without any fear that a charge hangs fire and the smoke is very light, because that resulting from burnt fuse is entirely avoided.

From November 1, 1865 to October 6, 1866 there were expended in sinking this shaft,—

Days of labor, including foremen,	7,674.5
Drills dulled,	41,056.
Inches of hole drilled,	136,876.5
Holes made,	3,272.
Pounds of powder used,	6,010.75
Feet of fuse used,	17,401.5
Pounds of candles used,	126.
Quarts of oil used,	1,087.75
Feet of progress made,	134.2
Cubic yards of rock removed,	1,745.9

This will give for one day's labor of one man,—

Drills dulled,	5.350
Inches of holes drilled,	17.835
Holes made,	0.426
Pounds of powder used,	0.783
Feet of fuse used,	2.267
Pounds of candles used,	0.016
Quarts of oil used,	0.142
Feet of progress made,	0.017
Cubic yards of rock removed,	0.227

Or one foot of progress requires the expenditure of,—

Days' labor of one man,	57.187
Drills dulled,	305.931

Inches of hole,	1,019.944
Holes,	24.382
Pounds of powder,	44.789
Feet of fuse,	129.668
Pounds of candles,	0.939
Quarts of oil used,	8.105
Cubic yards of rock removed,	13.000

There were 27,460.5 inches of $2\frac{1}{2}$ -inch holes, 109,171.5 inches of 2-inch holes, and 244.5 inches of $1\frac{1}{2}$ -inch holes.

We also find that the holes have an average depth of 41.832 inches, that each drill-bit cuts 3.334 inches of hole, and that each hole consumes 1.837 pounds of powder and 5.318 feet of fuse.

From October 6, 1866 to November 1, 1866, there were expended in sinking this shaft,—

Days of labor, including foremen,	901.75
Drills dulled,	4,280.
Inches of hole drilled,	19,486.5
Holes made,	437.
Pounds of powder used,	731.5
Abel's fuses,	451.
Quarts of oil,	134.25
Feet of progress made,	19.
Cubic yards of rock removed,	247:

This will give for one day's labor of one man,—

Drills dulled,	4.746
Inches of hole drilled,	21.610
Holes made,	0.485
Pounds of powder used,	0.811
Abel's fuses used,	0.500
Quarts of oil used,	0.149
Feet of progress made,	0.022
Cubic yards of rock removed,	0.274

Or one foot of progress requires the expenditure of,—

Days' labor of one man,	.	.	.	.	.	47.461
Drills dulled,	.	.	.	.	.	225.263
Inches of hole,	.	.	.	.	.	1,025.605
Holes,	.	.	.	.	.	23.000
Pounds of powder,	.	.	.	.	.	38.500
Abel's fuses,	.	.	.	.	.	23.737
Quarts of oil,	.	.	.	.	.	7.066
Cubic yards of rock removed,	.	.	.	.	.	13.000

There were 11,291 inches of 2-inch holes, and 8,195.5 inches of $2\frac{1}{2}$ -inch holes.

We also find from the above that the holes have an average depth of 44.592 inches, that each drill-bit cuts 4.553 inches of hole, and that each hole consumes 1.674 pounds of powder and 1.032 Abel's fuses.

No machine drills have been used here, as those intended for this purpose have been converted into horizontal ones for the East End. The air compressors, reservoirs, and pipes, are, however, all in place and ready for work.

The amount of water in the shaft is slight, only about 11 gallons per minute.

The following is a table showing the monthly consumption of fuel, oil, &c., in the engine-house.

DATE.	Number cords of Wood.	No. galls. Sperm Oil.	No. pounds Tal- low.	No. pounds Waste.	No. pounds Tar.	No. tubs Stone raised.	No. tubs Water raised.	No. tubs with Men or Tools.
November, 1865,	97.7	11	5	14	2	854	1,997	457
December, "	125.9	$11\frac{1}{4}$	$5\frac{3}{4}$	13	3	620	3,040	458
January, 1866, .	163.8	$18\frac{3}{4}$	11	$10\frac{1}{4}$	2	885	2,975	458
February, " . .	153.5	$14\frac{3}{4}$	4	$13\frac{1}{4}$	3	550	2,874	421
March, " . . .	145.4	$13\frac{1}{2}$	$21\frac{1}{2}$	$21\frac{1}{2}$	-	783	3,080	386
April, " . . .	132.0	11	2	$22\frac{3}{4}$	-	639	2,874	381
May, "	113.3	$13\frac{3}{4}$	8	$16\frac{1}{4}$	-	143	2,055	211
June, "	99.1	$11\frac{1}{2}$	6	14	-	-	-	-
July, "	101.7	$14\frac{3}{4}$	$9\frac{1}{2}$	$13\frac{1}{2}$	-	-	-	-
August, " . . .	99.4	$17\frac{1}{2}$	8	$20\frac{1}{4}$	11	464	1,150	364
September, " . .	87.5	$15\frac{1}{4}$	10	$14\frac{3}{4}$	2	829	1,035	444
October, " . . .	100.1	$14\frac{1}{2}$	$8\frac{1}{2}$	$9\frac{1}{2}$	-	882	1,015	468
Totals,	1,418.4	$167\frac{1}{2}$	$80\frac{1}{4}$	183	23	6,649	22,095	4,048

WEST SHAFT.

The work at this point has been uninterrupted during the year.

The progress made monthly in the headings and their enlargement, is shown in the following table:—

WEST HEADING.

DATE.	Distance from Shaft.	Progress.
August 2, 1865, stopped,	280.8 feet.	—
September 19, 1866, begun,	280.8 “	—
October 3, 1866, stopped,	298.0 “	18.2 feet.

HEADING ENLARGEMENT.

May 11, 1866, begun,	4.0 feet.	—
July 1, 1866,	100.0 “	96.0 feet.
August 1, 1866,	160.0 “	60.0 “
September 1, 1866,	225.0 “	65.0 “
October 3, 1866, stopped,	298.0 “	73.0 “
Total progress,	—	294.0 feet.

EAST HEADING.

HEADING.			ENLARGEMENT.		
DATE.	Distance from Shaft.	Progress.	DATE.	Distance from Shaft.	Progress.
November 1, 1865, .	367.5	—			
December 1, 1865, .	414.4	46.9			
January 1, 1866, .	459.4	45.0			
February 1, 1866, .	503.0	43.6			
March 1, 1866, .	546.5	43.5			
April 1, 1866, .	584.8	38.3	April 1, 1866, .	372.4	—
May 1, 1866, .	623.3	38.5	May 1, 1866, .	418.4	46.0
June 1, 1866, .	682.1	58.8	June 1, 1866, .	492.7	74.3
July 1, 1866, .	746.1	64.0	July 1, 1866, .	568.7	76.0
August 1, 1866, .	810.5	64.4	August 1, 1866, .	645.7	77.0
September 1, 1866, .	871.4	60.9	September 1, 1866, .	750.1	104.4
October 1, 1866, .	945.4	74.0	October 1, 1866, .	844.3	94.2
November 1, 1866, .	1,004.2	58.8	November 1, 1866, .	950.0	105.7
Total progress,	—	636.7			

The enlargement of the west heading has brought it to a size 15 feet wide and 10.5 feet high, except that the bottom has not been taken to grade. This is because the grade must, for the present, descend towards the shaft in order to vent the water, while the final grade must ascend towards the shaft. There remains about two feet of bottom to take up near the shaft and three feet at the west heading, which will be accomplished by the time the pumping engines are ready for the supplementary shaft, in order that all the water of the shaft may run to it.

The west heading has reached better rock than that in which it was left on the 2d of August, 1865, and as soon as sufficient pumps are ready, it will be driven again towards the West End, with almost a certainty of going through tolerably good rock for about one thousand feet, and perhaps more.

The east heading is enlarged to its full size of 15 feet wide by 10.5 feet high. In this heading, the experiments with nitro-glycerin were tried by Colonel Schaffner. Those in the

enlargement were upon the 8th, 9th and 10th of August, and those in the heading upon the 8th, 9th and 10th of October.

The enlargement was driven about *thrice* as rapidly as under the use of common powder, at a saving of \$3.64 per cubic yard of rock removed, while the heading was driven about *twice* as rapidly, at a saving of \$10.20 per cubic yard. These results have been heretofore given more in detail in my letter to you.

During the past year, in the east heading there have been expended,—

Days of labor, including foremen,	10,101.
Drills dulled,	188,505.
Inches of hole drilled,	447,450.
Holes made,	18,186.
Pounds of powder used,	9,704.
Feet of fuse,	40,896.
Pounds of candles,	3,447.
Feet of progress made,	636.7
Cubic yards of rock removed,	2,358.

This will give for one day's labor of one man,—

Drills dulled,	18.662
Inches of hole drilled,	44.298
Holes made,	1.800
Pounds of powder used,	0.961
Feet of fuse used,	4.049
Pounds of candle used,	0.342
Feet of progress made,	0.063
Cubic yards of rock removed,	0.233

Or one foot of advancement requires the expenditure of—

Days' labor of one man,	15.865
Drills dulled,	296.066
Inches of holes,	702.764
Holes,	28.563
Pounds of powder,	15.241
Feet of fuse,	64.231
Pounds of candles,	5.414
Cubic yards rock removed,	3.703

We also find that the holes have an average depth of 24.604 inches; that each drill-bit cuts 2.374 inches of hole, and that each hole consumes 0.533 pounds of powder and 2.249 feet of fuse. The holes are $1\frac{3}{8}$ inches in diameter, and being hand holes, not round, but rather triangular.

The hoisting apparatus has worked during the year most satisfactorily. The water has gradually increased until, at the end of the year, it amounted to 97 gallons per minute, or about as much as the pumps, running at their natural speed, could deliver.

The three men who had been lying in Lenox jail awaiting trial by a higher court, for burning the West Shaft buildings in February, 1865, were released in January, 1866, the grand jury failing to indict them.

The following is a table showing the monthly consumption of fuel, oil, &c., in the engine-house:—

DATE.	No. tons Coal.	No. cords Wood.	No. gallons Oil, (Sperm.)	No. galls. Kero- sene.	No. of pounds of Waste.	No. Cages raised.	No. cars of Stone raised.
November, 1865,	57.832	—	20 $\frac{1}{4}$	7 $\frac{3}{4}$	2	2,702	1,516
December, “	40.450	29.9	18 $\frac{3}{4}$	8 $\frac{1}{2}$	2 $\frac{1}{2}$	2,468	1,052
January, 1866,	—	106.	20 $\frac{3}{4}$	8 $\frac{1}{2}$	1 $\frac{1}{2}$	2,175	1,106
February, “	—	91.4	16 $\frac{1}{2}$	7 $\frac{1}{2}$	2 $\frac{1}{2}$	2,282	880
March, “	35.250	63.6	17 $\frac{1}{2}$	8	2	2,457	1,119
April, “	57.025	24.9	14	5	1 $\frac{1}{2}$	2,199	1,165
May, “	50.350	12.7	12 $\frac{1}{2}$	4 $\frac{1}{2}$	4	2,686	1,512
June, “	70.985	—	14	3 $\frac{1}{2}$	8 $\frac{1}{4}$	3,089	1,820
July, “	45.550	31.0	14 $\frac{1}{2}$	3 $\frac{1}{2}$	2 $\frac{1}{2}$	2,899	1,816
August, “	—	67.1	18	6	4	3,291	2,051
September, “	—	60.4	15 $\frac{1}{4}$	9	5 $\frac{1}{2}$	3,352	2,143
October, “	—	66.0	16 $\frac{1}{2}$	7	4	3,135	1,945
Totals,	357.442	553.0	148 $\frac{1}{2}$	78 $\frac{3}{4}$	40 $\frac{1}{4}$	32,735	18,125

WEST SUPPLEMENTARY SHAFT.

Under the head, Line, the necessity for this shaft in order to verify the line was stated. It would have been more satisfactory in an engineering point of view, could it have been located further from the West Shaft. But when it was begun it was very uncertain whether the west heading could be driven further without drowning the shaft workings. It must, therefore, in order to be available, open into the west heading already driven. Nor was it desirable to have it penetrate through the bad rock, in which the heading had to be stopped. It was therefore located so that it would probably come down through good rock, in order to avoid a great flow of water, and the necessity for timbering.

It was thought to be very difficult to bore a hole of only a few inches in diameter so nearly vertical as to answer the purpose for line. And upon conferring with miners, it was found that a shaft of the size decided upon, could be sunk at very little more cost than a smaller one.

It was also found that something must very shortly be done at the West Shaft to increase the pumping capacity. There was not room for larger pumps in the West Shaft, except by taking out the present one, which would for awhile occasion a suspension of the work.

The West Shaft is 316 feet deep; the Supplementary, 277 feet; and by running a small drift into it from a north-westerly direction, a further saving of forty-one feet could be effected. This would reduce the lift of water about eighty feet, or to 236 feet, thus saving one-fourth of the expense of pumping the water for several years, enough probably to pay the entire cost of the new shaft. It was therefore determined to make the shaft six feet by thirteen feet in the clear, the last dimension being at right angles to the Tunnel line. By putting a foot timber in the middle of the shaft, it is divided into two parts, six feet by six feet each. In each of these a pump could be put large enough to lift all the water which could reasonably be expected, and then a reserve pump would be constantly in readiness for a breakdown, or a sudden large influx of water.

The small drift has been run into this shaft and was completed April 22, 1866. It is six feet high, four feet wide at bottom, and two feet at top. It is 101.5 feet long, 72.5 feet

having been in earth which required timbering. It cost \$698.50 under contract for labor. The shaft is being sunk by contract, at a cost for labor of from \$40 to \$60 per foot.

It is being driven both from above down, and from below up, and the progress has been as follows.

The whole depth is to be 277 feet.

FROM ABOVE DOWN.			FROM BELOW UP.		
DATE.	Distance down.	Progress.	DATE.	Distance up.	Progress.
	Feet.	Feet.		Feet.	Feet.
December 11, 1865, .	—	—			
January 1, 1866, . .	27.0	27.0			
February 1, 1866, . .	31.0	4.0			
March 1, 1866, . . .	65.0	34.0			
April 1, 1866, . . .	89.0	24.0			
May 1, 1866,	101.0	12.0			
June 1, 1866,	116.5	15.5			
July 1, 1866,	135.0	18.5			
August 1, 1866, . . .	151.0	16.0			
September 1, 1866, .	160.0	9.0	September 19, 1866, .	13	—
October 1, 1866, . . .	169.0	9.0	October 1, 1866, . . .	16	3
November 1, 1866, . .	177.5	8.5	November 1, 1866, . .	36	20
Progress down,	—	177.5	Progress up,	—	23

It is expected that this shaft will be completed in February next. The charges are being fired by electricity to expedite the work. The quantity of water now being pumped is thirty gallons a minute.

WEST END.

Under this head in a former report, was a table giving the details concerning the wells or test pits which were being sunk, in order to ascertain the nature of the material. This work has been completed, and the table is again introduced with the blanks filled.

WELLS OR TEST PITS.	No. 1.	No. 2.	No. 3.	No. 4.
Distance from West Shaft—feet, .	2,091.5	1,976.5	1,713.2	924.2
Surface above sub-grade, “ .	79.5	117.9	134.0	215.0
Depth of well, “ .	38.0	51.0	67.0	103.3
Depth of boring below well, “ .	43.5	50.0	68.3	—
Reaching a point above or below sub-grade,	—2.0	+16.0	—1.3	+101.7
Top of rotten rock below surface, .	13.0	46.0	67.0	None.
“ “ “ above grade, .	66.5	71.0	67.0	None.
“ solid “ below surface, .	None.	None.	None.	77.0
“ “ “ above sub-grade, .	None.	None.	None.	138.0

The result of these examinations is most encouraging. At Well No. 3 the borings came from such great depth that the character of the material could not certainly be ascertained. It seemed very much closer, harder and dryer than the rotten rock passed through in Wells No 1 and 2; and several strata were passed through that required drilling, the boring tools not being able to penetrate them.

The material brought up was finely pulverized, and on comparison with powdered stone from Well No. 4, proved to be quite similar.

Well No. 4, was begun of large size,—10 feet internal diameter,—and reached the rock 77 feet down with a diameter of about 8 feet. It is located in the hollow west of the West Shaft, where bad material would be more likely to occur than at any other point between the West End and West Shaft, and where there was every probability of large quantities of water.

It was made large with the hope that, everything proving favorable, it might be sunk to grade, and used as a shaft. Much troublesome quicksand was passed through in going down 52 feet, when a tight, hard pan was reached, which continued for a distance of 25 feet, when rock was reached. This proved to be scienitic in character, and hard, though cut through in various directions by seams.

There was very little trouble experienced in sinking it to a further depth of 26 feet, when a large sand seam was struck.

This discharged so much water, that it was beyond our then ability to free the well, and it was abandoned temporarily, perhaps the main object of the well having been attained.

This is not conclusive proof, but it leads to the presumption that the west heading of the West Shaft can easily be driven to this point, and, judging from the configuration of the ground still farther west and the developments of Well No. 3, for a much greater distance. It will be necessary, however, to provide ample means for pumping beforehand.

These facts put a much more favorable aspect upon this part of the work, than could presumptively be done in the last report.

In the middle of January, the West End heading was resumed again, and was driven with very tolerable success, passing through 30 or 40 feet of hard rock to a point 2,128.5 feet from the West Shaft.

About this time, a contract was made by the Commissioners with B. N. Farren to undertake this work, and the further prosecution of it by the State was suspended. This contract provides for the arching of 174 lineal feet west of the point where the Tunnel passes beneath ground, and for building at least 200 feet of Tunnel east of this point, before the 30th of June, 1867.

The following table gives monthly progress of completed Tunnel to November 1, 1866 :—

DATE.	Distance from Ins. Pier.	Distance from West Shaft.	Progress.
Aug. 9, 1866,	68.5 feet.	2,378.5 feet.	
Sept. 1, "	100.5 "	2,346.5 "	32.0 feet.
Oct. 1, "	164.0 "	2,283.0 "	63.5 "
Nov. 1, "	200.0 "	2,247.0 "	36.0 "
Progress to Nov. 1, 1866,			131.5 "

Since that time, the whole of the 174 feet has been completed, and the tunnel has passed beneath ground.

It has been found that the heading driven by the State had so far dried the material through which the 174 feet passes,

that it was comparatively easy to put in the masonry. Acting upon this experience, Mr. Farren has been permitted to drive a small heading on each side of the Tunnel and some distance outside of its section, in order to drain away the water, and make it possible to push on the Tunnel by the usual process of timbering.

The southerly one is already 20 feet in advance of the point to which he is under contract to build, and the northerly one is well on. They have reached dryer ground than most of that through which they have passed; and it seems advisable to push them on to reach a material through which tunnelling can be done without any question, so that all may feel that this great apparent obstacle to the completion of the Tunnel has been surmounted.

Diagram No. 2 gives the form and size of masonry through the 174 feet already built. A round Tunnel was recommended in the former report, because there was then a chance that the rotten rock reached to the West Shaft, and that an invert would be required for nearly all the distance.

But the information afterwards acquired from the test wells, made it probable that it did not extend beyond a few hundred feet. In order therefore to secure more width at the grade line, and make it conform more nearly to the rock section, the form was modified as shown in the diagram.

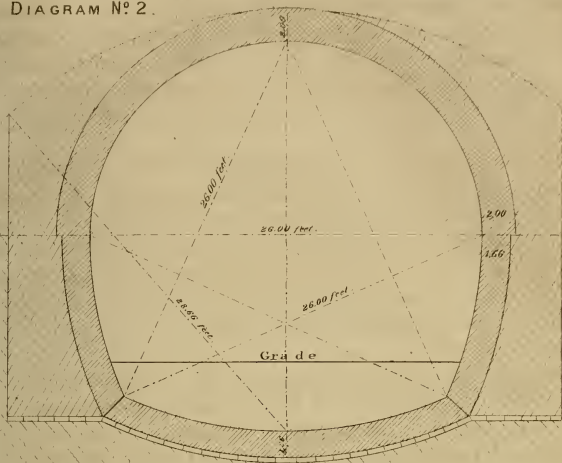
Afterwards, under a suggestion from George Berkley, C. E., who was familiar with workings in the London clay, the form was still further modified, and that part east of the 174 feet, or beneath ground will be of the shape indicated in Diagram No. 3.

This masonry is built of brick, and through the 174 feet it is from five to eight courses or rings in thickness, increasing towards the east; eight rings give a thickness of 32 inches.

The large expense heretofore incurred on this part of the work, brought it at length into a state in which it seemed best to begin full size tunnel and line it with masonry.

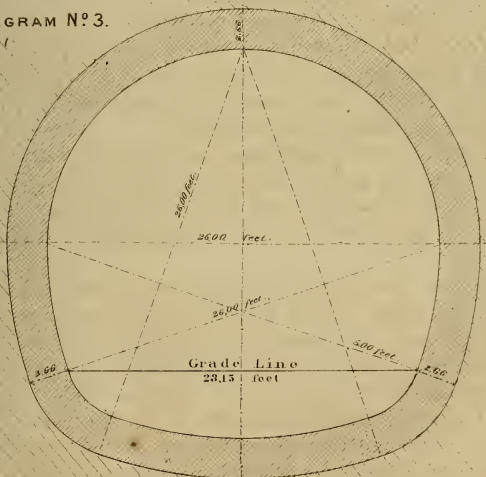
As before remarked, the removal of the quicksand from overhead, the making and maintaining of surface ditches, and the driving of the heading, had so far *restored the morals* of the rotten rock, by taking away the water, that the contractor found it comparatively easy to do his work. He also found

DIAGRAM Nº 2.

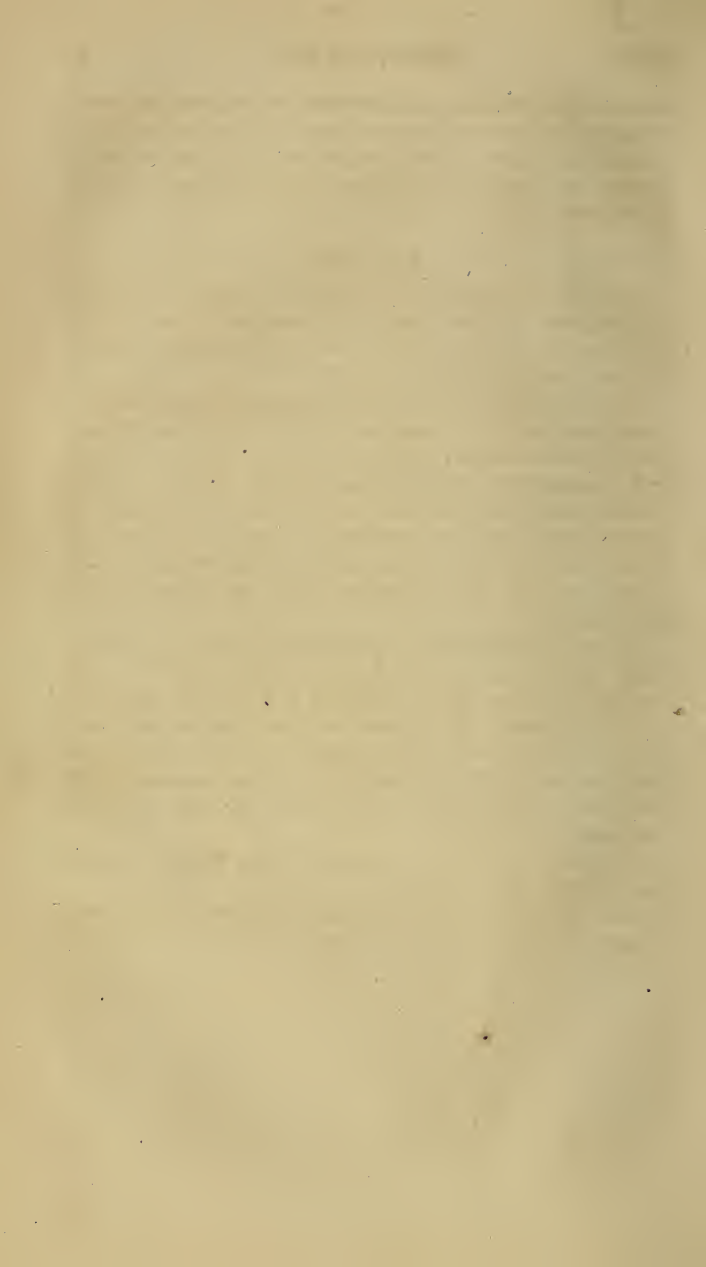


Scale 10 feet to 1 inch

DIAGRAM Nº 3.



T. Doane.



tracks, roads, buildings, &c., ready for his use, and the Commissioners, under the contract furnish to him at about cost price, all the brick, timber, lumber, cars, &c., that he needs, so that his time and energy can be devoted exclusively to driving on the work.

BRICKYARD.

As stated in my former report, land has been bought which furnishes both clay and sand for brick-making. There is probably a superabundance of clay for tunnel purposes, but the sand is in limited quantity.

The clay proves to be of most excellent quality, and the freshly moulded brick have endured both heavy showers and severe frosts excellently well.

At considerable expense, because of the roughness of the ground, a brickyard has been graded near the West End. It is 300 feet long and 120 feet wide, including the kiln shed. It is furnished with four mixing and moulding machines, made by Mr. George F. Blake of Boston, which are driven by a 20-horse engine.

The machines were set up and operated through the season under the direction of A. H. Keay, of Boston, while the burning has been under the more especial care of B. F. Hathaway, of North Adams. The clay and sand have been mixed, except those of the first kiln, in the proportion of 2 of clay to 1 of sand, care being taken to select clay free from loam and stones, and sand coarse and clean. No coal dust has been used in the composition of the brick.

The moulding of brick commenced on the 26th of June and ended on the 24th of October.

The following table is a record of number of kilns burnt, number of bricks, and dates of burning.

No. of Kiln.	No. of Bricks in.	Begun Burning.	Ended Burning.
1	150,000	July 12, 1866, . .	July 21, 1866.
2	230,000	August 2, 1866, . .	August 9, 1866.
3	350,000	August 22, 1866, . .	August 29, 1866.
4	330,000	October 1, 1866, . .	October 9, 1866.
5	610,000	November 2, 1866, . .	November 10, 1866. .
	1,670,000		

The moulds measure $8\frac{11}{16}$ by 4 by $2\frac{1}{2}$ inches, or $88\frac{1}{2}$ cubic inches.

The bricks measure from $7\frac{7}{10}$ by $2\frac{3}{4}$ to $2\frac{3}{10}$ by $3\frac{4}{10}$ to $3\frac{1}{2}$ inches, or $61\frac{98}{100}$ cubic inches, and weigh from $3\frac{3}{4}$ to $3\frac{15}{16}$ pounds each.

About 80 per cent. of the brick are sufficiently hard for lining the Tunnel. They prove to be of very superior quality, being tough, solid and of good shape. Their power to resist crushing has not been tested. Probably a somewhat larger brick will be made next season, and the admixture of a larger proportion of sand may make as good a brick, that will shrink less. Enough bricks are on hand, it is thought, to last till next brick season. This part of the work is now in a state of preparation to be operated under contract.

The cost of brickyard is included under West End expenses.

EXPENSES.

The following is a statistical account of expenses from the re-opening of the work in 1863 to November 1, 1865.

The first column gives the expenses to November 1, 1865; the second column gives the total expenses to November 1, 1866; the third column gives the expenses for one year from November 1, 1865 to November 1, 1866:—

	First.	Second.	Third.
Engineer'g, Superin., &c.,	\$55,999 '90	\$84,840 48	\$24,840 58
Deerfield Dam, . . .	125,919 74	127,982 80	2,063 06
Excav. and Masonry East End Dam, . . .	12,535 86	12,802 46	266 60
Wheel-pits and House, .	45,878 09	70,723 23	24,845 14
Gates and Overflow, .	9,419 73	9,986 26	566 53
Race or Canal, . . .	21,353 03	23,417 54	2,064 51
East End Enlargement, .	80,317 19	80,317 10	—
E. End Head., Hand Lab.	32,425 88	103,731 45	39,237 09
“ “ “ Mach. “	—	—	32,068 48
“ “ Head. Enlargem't,	12,602 68	17,559 46	4,956 78
Central Shaft, . . .	85,525 58	144,423 75	58,898 17
West Shaft, . . .	75,778 60	179,041 69	103,263 09
West Approach, . . .	134,794 62	247,900 75	113,106 13
Building East End, . .	27,851 65	31,688 99	3,837 34
“ Central Shaft, . .	9,620 43	12,026 83	2,406 40
“ West Shaft and West End, . .	33,076 42	40,010 13	6,933 71
Building General, . . .	7,694 39	9,537 37	1,842 98
Machin'ry Deerfield Dam,	10,297 92	10,820 93	523 01
Machinery East End, .	20,537 79	37,032 38	66,494 59
“ Central Shaft,	22,472 93	51,364 01	28,891 08
“ West Shaft,	36,388 62	57,111 73	20,723 11
“ “ End, . . .	36 62	539 89	503 27
“ General, . . .	18,927 68	62,600 76	43,673 08
Land and Right of Way,	8,613 84	17,513 21	8,899 37
Miscellaneous, . . .	556 62	<i>Trans. to Troy & Greenfd R. R.</i>	
	\$892,625 72	\$1,482,973 20	\$590,904 10

Engineering and Superintendence includes, besides engineering proper, the cost of superintendence, the cost of all engineering instruments, the expenses of cashier's office, the barn account of engineers and superintendents, some expenses of Commissioners and Consulting Engineer, and the cost of the four instrumental station-houses.

The following is a statistical account of expenses for one year from November 1, 1865, to November 1, 1866.

The first column gives the total expenses of all sorts, under their various heads.

The second column gives the amounts, by estimation, which may be considered as not really spent, but put into buildings, machinery, fixtures, &c., and which are available for further use; that is, they are amounts spent in view of work yet to be done.

The third column gives the amounts which have been really spent in the work, and which are of no further use except as they constitute a part of the expenses necessary in constructing the Tunnel :—

	Expenses for One Year.	Expenses of Further Use.	Expenses of no Further Use.
Engineering, Superin'dence, &c.,	\$24,840 58	\$13,135 91	\$11,704 67
Deerfield Dam,	2,063 06	2,063 06	—
Excav. & Mas. East End Dam, .	266 60	266 60	—
Wheel-pits and House, . . .	24,845 14	16,987 00	7,858 14
Gates and Overflow,	566 53	566 53	—
Race or Canal,	2,064 51	2,064 51	—
East End Enlargement, . . .	—	—	—
East End Heading, Hand Labor,	39,237 09	—	39,237 09
“ “ “ Mach. “	32,068 48	—	32,068 48
“ “ “ Enlargem't,	4,956 78	963 47	3,993 31
Central Shaft,	58,898 17	639 48	58,258 69
West “	103,263 09	—	103,263 09
West Approach,	113,106 13	768 77	112,337 36
Building East End,	3,837 34	935 22	2,902 12
“ Central Shaft,	2,406 40	1,359 02	1,047 38
“ West Shaft & W. End,	6,933 71	3,520 43	3,413 28
“ General,	1,842 98	1,842 98	—
Machinery Deerfield Dam, .	523 01	—	523 01
“ East End,	66,494 59	64,278 69	2,215 90
“ Central Shaft,	28,891 08	26,467 71	2,423 37
“ West Shaft,	20,723 11	16,775 71	3,947 40
“ West End,	503 27	—	503 27
“ General,	43,673 08	18,035 13	25,637 95
Land and Right of Way, . .	8,899 37	8,899 37	—
	\$590,904 10	\$179,569 59	\$411,334 51

Taking the whole time since the assumption of the work,
and the total expenses will be seen to be . . . \$1,482,973 20
Total amount put into buildings, machinery, &c., 673,531 24
absolutely spent in the work, . . . 809,441 96

The buildings and machinery represented by the above large outlay seem to have been necessary in the way of preparation for the energetic prosecution of the work. The enlargement must soon be actively entered upon, and if this is done by contract it will not perhaps be required of the State to erect many more buildings.

It will now be necessary without delay to add very largely to the present ability to pump water at the West Shaft, and soon to make provision for increased ventilation there. This will involve considerable further outlay for plant, but beyond this it is hoped that for one or two years very little more will be required, and that whatever is spent upon the work will be visible in actual progress, proportional to the amount provided.

Diagram No. 4 is a profile of the Hoosac Mountain, and upon it is indicated the amount of work already done.

THOMAS DOANE, *Chief Engineer.*

CONSULTING ENGINEER'S REPORT.

BOSTON, December 18, 1866.

To His Excellency Gov. BULLOCK, *and the Honorable Executive Council of the Commonwealth of Massachusetts.*

As Consulting Engineer, appointed under the third section of the Act approved May 30th, 1866, I beg leave respectfully to report, as contemplated therein and as requested by you, upon the progress and condition of the work upon the Troy and Greenfield Railroad and Hoosac Tunnel, and upon the plans for the prosecution of the same.

TROY AND GREENFIELD RAILROAD.

In my report on the 31st of August last, I communicated the result of my examination of the thirty miles of road between Greenfield and the Tunnel, and recommended that it be placed at once under contract, which has accordingly been done by the Commissioners with your approval.

The work is now reported by them to be actively progressing upon the thirteen miles between Greenfield and Shelburne Falls, the contractor confining his operations at present to this section of the route, as important to be opened first, and as containing the heaviest work. He is bound to complete it to Shelburne Falls by November 15th, 1867, and to the Tunnel by July 15th, 1868, and I think, may, with proper effort, anticipate both of these periods. As the road is extended, section by section, it will of course carry with it increased facilities to the work in the Tunnel by improved conveyance for hands and supplies, as well as bring the Tunnel from its present insulated position more into view, increase the interest felt in it by those

most concerned in its completion, and promote a more general appreciation of its magnitude and value. The lease of the thirty miles of the Fitchburg and Vermont and Massachusetts Railroad Companies, also recommended in my report just referred to, has been made, and the immediate extension of trade and travel over it, and of revenue therefrom, has been thus secured without farther expense to the Commonwealth.

HOOSAC TUNNEL.

Passing now to the subject of the Tunnel, I have respectfully to submit the following statements and opinions in regard to its condition and progress, and the best means of securing its speedy and economical prosecution. Having on the 12th inst. visited the work for the third time, and spent several days upon it in conference with the Commissioners and Engineer, I am enabled to express more decided views upon the points referred to in my previous reports, and of which I will now speak under their respective heads.

THE MACHINE-DRILLS.

In my report of 29th October, I expressed a hope that the new machine then in preparation at Fitchburg, would be found to wear so much better than the one then in use, as to make its more rapid action when at work, substantially available to insure greater speed in the general advance of the heading. My expectations were not wholly disappointed, as the new drill, from its greater simplicity of form, and the smaller number of its parts subject to the most violent of the shocks experienced in its various movements, was found to require less frequent repairs. From carefully questioning the intelligent head mechanic, (Mr. Hall,) having charge of the machine shop at the east end of the Tunnel, I inferred that the improved machine was capable of doing full twice the duty of the previous one, and that its repairs would be less costly in even a more favorable proportion. In reply to my farther inquiry whether he considered the new machine susceptible of still further improvement, I understood him to say that he thought it could not be made *materially* better; that it was composed of as many distinct parts, (such as screws, pins, ratchets, cams, pistons, &c., &c., amounting to no less than eighty in all,) as

the older machine; and although, as fewer of those parts accompanied the drill-bar in its blow against the rock, there would be less general wear and tear, the complexity of structure necessary to accomplish all the motions required of it must make it unavoidably subject to rapid wear and repeated breakage. There were six of the machines at the Tunnel during my visit, one-half of which were at work in the eastern heading and the other half in the shop, and of the three at work, one had its "feed movement" out of order, and was being fed by hand. Indeed I will here remark that, inasmuch as three men were required to operate each machine, the rotary and the forward or feed movement, or at least the latter, might perhaps better be done by one or more of them, and the parts of the machine now effecting these motions automatically, be dispensed with, to the simplification of the machine and its consequent improved wear. The danger, however, in this case would be, that a careless performance of the duty might lead to the binding of the bit in the hole, and to consequent breakage or loss of time in the operation of the machine, all of whose movements must be in that harmony with each other which can only be perfectly secured by making it automatic throughout. I must admit, that, on the whole, I was less encouraged by my late visit than before, to hope for improved progress in the work by the use of the machine, even in its improved form, and I am induced to doubt more than before whether an apparatus, necessarily so delicate in its structure and subjected to such incessant and violent shocks, can be made to do its work with *economy* and *rapidity* combined. The increased advance at Mt. Ceniz, due it would seem to the machine drill, has been the foundation of expectation and effort in this direction for the three years which have elapsed since the Hoosac Tunnel became a State enterprise, and it would seem unwise, in the face of the success attending the use of such an instrument at that great work, to abandon the attempt to make it do here what it has done there.

Unfortunately, indeed, we are without specific or reliable information as to the Italian work, nor would it seem possible to obtain it unless by personal visit or minute observation; the professional journals and general press giving only vague and popular accounts of it. The drilling machine employed there,

as described by Mr. Storrow in his report to the Commissioners in 1862, and as shown by a drawing now in the office at North Adams was more bulky, cumbrous and complicated than the one first in use at the Hoosac Tunnel, the latter as stated by the Commissioners in their reports to the governor and council of January 1865 and 1866, being the result of their assiduous endeavors to avoid the defects of the Mt. Ceniz machine. Yet the progress of the heading at Mt. Ceniz was, as reported by Mr. Storrow, considerably expedited by the machine used there notwithstanding those defects, and it was reasonable to look for still better results at the Hoosac Tunnel, from a machine promising improvement in several respects.

The issue has, in fact, however, been otherwise, thus far, as the heading here, during the six months for which the machine-drill has been at work, is reported to be some 75 feet short of the point it would have reached at the previous rate of progress, by hand labor.

This unfavorable result, as regards forward movement, was compensated, in a measure, by the removal of more rock per linear foot of the heading, counted in cubic yards, and was also, no doubt, in good part owing to the very limited stock of machines in use, more than half of which have been in the repair shop at a time. Had a constant supply of machines been maintained, so that the moment one had become disabled another would have been substituted, the result would, doubtless, have been better.

Yet even in this case, it is evident that there must have been a much greater loss of time in detaching the drill from its carriage and attaching its substitute, than in changing a dull drill for a sharpened one in the hands of a miner.

In view of these circumstances and considerations, it appears that the alternatives now presenting themselves are,—

1. To proceed with the use of the machines now on hand, in their present improved form, and by multiplying their number as rapidly as possible, to avoid, as much as may be, the loss of time attendant upon their frequent breakage.

2. To discontinue their use for the present, and return to hand labor in the Tunnel until further experiments can be made outside of the Tunnel with this as with other forms of machine. Or,

3. To lay them aside entirely, and depend altogether upon hand labor for the future. I do not feel prepared at present to recommend the third of these alternatives, for I do not yet despair of ultimate success with some form of drilling machine; but I apprehend that until the drawbacks attendant upon the present machine—ingenious as it is, and superior as it is to its predecessor—are removed, a persistence in the present mode of operation will be attended with serious delays and a great increase of expenditure.

The progress at the east heading, from November 1, 1865, to June 8, 1866, ($7\frac{1}{4}$ months,) was by hand labor 400.5 feet, or at the rate of $55\frac{1}{4}$ feet per month, while for the remaining $4\frac{1}{2}$ months, (deducting a week of suspended work, while the machines were being introduced,) the progress was 191.5 feet, or at the rate of $42\frac{1}{2}$ feet per month. I have not the data at hand to compare the relative cost of the two modes, but as the same amount of manual labor, powder, etc., was required in both cases, the expense of the machine-drilling must, notwithstanding the greater *proportional* number of cubic yards removed, have been the largest, not only on account of the slower forward progress, but the cost of repairing the machines. In watching the working of the machines, I noticed that the provision for injecting water into the drill-holes was but partially availed of, on account of its ejection in the faces of the miners when the holes pointed upwards, as they must do in the upper half of the heading.

This is a disadvantage in the use of the machine-drill which does not affect the hand-drill, the more rapid blow of the former tending to heat the bit, and by injuring its temper, cause it to wear much faster, and hence requiring water to keep it cool. It must also be observed, that with all the facility for directing the drill to different points, which the very well designed and constructed carriage affords, it cannot afford the miner the same means of using his skill and judgment in planting the drill holes so as to produce the best effects in blasting, and especially in the rock of this Tunnel, with its peculiar dip requiring the holes to be as much inclined upwards or downwards as possible. If it be furthermore contended that the machine-drill requires the heading to be driven at or near the bottom of the Tunnel, as it is being driven here and at Mt.

Cenis, it involves, in my opinion, an additional disadvantage in the economy of the work, of which I will speak more fully hereafter.

Reviewing the whole subject of the machine drill, as connected with this work, I would recommend the adoption of the second alternative above presented, viz., that the use of the machines in the Tunnel be discontinued for the present, and hand labor be resumed while the present improved machines, and any other which may be proposed and promise better results as to wear and tear, be subjected to thorough and continued trial at some suitable point in the neighborhood of the Tunnel, say at the eastern end, where the motive power is to spare, and the machine shop is under the direction of a skilful mechanic, familiar with such machines.

In suggesting this course, I think I am offering to this beautiful invention, so creditable to the mechanical genius of those who planned it, a better opportunity of establishing itself in the confidence of those in charge of this work and of the public at large, than if it should continue to operate under its present disadvantages within the Tunnel.

The interest which the Commonwealth has in the success of any machine which promises to promote the progress of this work, and to reduce its cost, or at least to hasten the time when its commercial advantages may be realized, should reconcile her to the moderate expense attendant upon the experiments proposed, insignificant as it must be, compared with that resulting from the retardation and increased cost of the work due to the conduct of the same experiments within the Tunnel. By the time these experiments will have reached some conclusive result, say within the next six months, more certain information may be obtained from Mt. Cenis, and the question be satisfactorily settled as to the real value of the machine drill. The progress made by hand labor in the east heading during the last year, has fully confirmed the estimate in this particular of the commissioners in their first report of February 28, 1863, having been 55 feet per month, as assumed by them, and also by Mr. Laurie in his report to them of January 10, 1863. Mr. Storrow put the probable progress at 60 feet per month in his report of November 28, 1862.

In my own report of October 1, 1862, I assumed 50 feet as the monthly rate, and am of course well pleased to find that I was quite safe in so doing. There has therefore been no disappointment in the actual result of hand labor on the end workings of the Tunnel, to which alone it was proposed to apply the machine-drills. It is indeed to be regretted that the naturally sanguine expectations of immediate success with the machines should have occasioned any delay whatever in the progress of the Tunnel; but the time lost on this account has not been great, and need be a subject of reproach to no one. I would add, that if the Commissioners think it best to postpone the withdrawal of the machines from the Tunnel, until farther experience be had of their work, with an increased number of them in operation, I see no objections to this course, as the machines can be used in the enlargement, of which I will speak hereafter.

PRESENT CONDITION OF THE WORK AND PROGRESS TO THIS TIME.

The railroad between Greenfield and North Adams was taken possession of by the Commissioners in September, 1862; and the condition in which they found the work, in all its parts, as left by the former contractors, Messrs. Haupt & Co., is exhibited in their two first reports to the governor and council, of February 28, 1863, and January 12, 1865. When the work was resumed by the State in October, 1863, there had been driven by the contractors 2,124 feet of tunnel at the East End, about 14 feet wide, by 18 to 19 feet high, intended by them as the full section of the Tunnel, when completed and designed only for a single track.

In advance of this, there was 270 feet of heading, the whole amount of excavation being about 17,000 cubic yards. The West Shaft was sunk to grade, and headings, 32 feet east and 25 feet westward, had been driven by the contractors as a commencement of the Tunnel proper at that point. At the West End, the approach cutting had been made, and some 550 feet of tunnel driven, and in part supported by timbering, and in part arched with stone. A good portion of this had broken in from above, and the Commissioners having decided, in concurrence with the advice of Mr. Laurie and myself, to raise the grade at this point from 25 to 30 feet, it was deter-

mined to extend the open approach cut so as to supersede this piece of tunnelling. It was accordingly so arranged ; and the total length of the Tunnel would have been thus reduced 988 feet, or from 25,586 feet, as ascertained by careful re-survey, to 24,598 feet, or $4\frac{660}{1000}$ miles. The Commissioners, however, subsequently decided to raise the grade at the West Portal only six feet above its level, as established by the tunnel of Messrs. Haupt & Co., and to shorten the Tunnel only 624 feet, or to 24,862 feet, or $4\frac{702}{1000}$ miles. The reasons for this change of plan are not stated in their report of December 20, 1864 ; and the report of the Chief Engineer, Mr. Doane, simply states the fact of the change, and refers to its approval by the Commissioners. I have seen no reason to change the views expressed in my report of October, 1862, in favor of an elevation of the level to the full extent of 25 feet at this point, and cannot but regret that it was not done ; but the large amount of work already executed in the present location, at a heavy expense, forbids the idea of abandonment now.

The lower grade has the cheapening and shortening to some extent of the line between North Adams and the Tunnel, to compensate in a measure for the increase in the length of the Tunnel, as above named, and of the difficulties which may be attendant upon driving it through the decomposed rock west of the West Shaft.

The able and elaborate report of the Commissioners of February 28, 1863, fully details the plan on which they proposed to conduct the work.

The adoption of a Central Shaft was a judicious measure, and, as I will show farther on, will greatly expedite the completion of the work.

Had the work at the West Shaft progressed as fast as was then presumed, the Central Shaft might have been sunk where the ground was some 300 feet lower, at a considerably less expense, and with nearly equal effect in advancing the work in the Tunnel. As the whole work now stands, it is, however, in about the best position for the last-named object.

One of the first measures of the Commissioners was an accurate retrace of the line of the Tunnel, by which re-survey it was discovered to deviate from a perfectly straight line, and the mode adopted by the Chief Engineer, Mr. Doane, of correct

ing this with the least sacrifice of work done, was judicious, and is described in his first report.

It is certainly better to have the Tunnel perfectly straight, although not indispensable, provided the curvatures were very gentle. It is not to be apprehended that there will be any failure in the meeting of the different workings, but should they not hit exactly it is well to know that a partial miss will not be fatal to the work.

WORK DONE UNDER THE COMMISSIONERS SINCE THEY TOOK CHARGE.

First.—At the East End. The State having taken up this part of the work where the contractors left it, the bottom or floor of the Tunnel, where it had the full section of fourteen by nineteen, was first brought to a regular grade. This was a tedious and expensive operation, and occupied an entire year, and until it was completed no advance was made in the heading or enlargement.

I will have occasion to offer a remark in this connection farther on.

The bottom of the contractors' tunnel having been then regularly graded on an ascent of about eighteen feet per mile up to the breast where the contractors' heading began, 2,124 from the East Portal, the next operation was to reduce the bottom of that heading, which extended about 275 feet beyond the breast to a height of four and one-half feet above grade, instead of the twelve feet at which it had been driven by Haupt & Co.

It was also widened to fifteen feet, from eleven feet, its previous width.

This additional move then brought the Commissioners' work up to the extreme end of the contractors' preceding work, at a distance of 2,399 feet from the East Portal, and this event took place, as stated in the Chief Engineer's report of December 15, 1865, on the fifteenth of March of that year, since which date the work has consisted of the new heading carried on by the State. On the first of November, 1865, it had reached, in seven and one-half months intervening, a distance of 2,839 feet from the East Portal, the total progress being 440 feet, at an average rate of sixty feet per month very nearly. In the month

of August, 1865, sixty-nine and one-half feet were driven, and in October, sixty-three and one-half.

The advance was therefore very encouraging, and was effected entirely by hand labor, showing what that sort of labor could accomplish. The widening of the heading from eleven to fifteen feet worked extremely well, as shown by Mr. Doane in his report now quoted, where it is seen (page 43,) that the enlarged section improved the useful effect of the manual labor in a remarkable degree, viz.: in the inches of holes drilled, 40 per cent.; in cubic yards of rock removed, 70 per cent.; and in forward movement of the work, 23 per cent. From this valuable experiment we must observe how much more economically the whole work of tunnelling can be done with a large than with a small area. From November 1, 1865 to November 1, 1866, the east heading progressed 592 feet, and reached a point 3,431 feet from the East Portal, the advance being at the rate of a fraction less than fifty feet per month.

As already stated, however, when treating of the machine-drills, the slower progress made by them during the last four and one-half months of the year has affected the general result; the advance by hand labor in the seven and one-fourth months from November 1, 1865 to June 8, 1866, being fifty-two and one-half feet per month, while that of the machines in the four and a half months from June 14 to November 1, 1866, was forty-two and one-half feet per month, which is about the rate at which the heading is advancing since the first ultimo. I will have occasion hereafter to recur to this statement of progress at the East End.

Central Shaft.—The work here was begun in December, 1863, and at the date of the Chief Engineer's report of September 19, 1864, it had been sunk about seventy-four feet, of which twenty-five was through earth, and the rest through rock. Much time was necessarily consumed in the preliminaries of this work, such as the walling of the upper section to secure it from caving, and provide a foundation for the house to contain the hoisting, pumping and ventilating machinery, and the apparatus for lighting. It is not to be wondered, therefore, that in a locality difficult of access like this, their preparations should have consumed so many months, and this could be better

understand if the substantial structure of the buildings and the superior quality of all the machinery were personally seen. The purchase of the farm on which these improvements stand was a very judicious measure. The sinking of the shaft was suspended from September 23, 1864 to March 22, 1865, while waiting for the improved machines, and by November 1, of the last year it had reached a depth of 201 feet. Its average rate for the seven and one-fourth months was nearly eighteen feet per month, and in August of that year 23 feet was made. This was, on the whole, encouraging, as the Commissioners had allowed a progress of twenty feet per month, Mr. Laurie twenty-one, Mr. Storrow twenty-one and five-tenths, and myself but sixteen and two-thirds feet in our reports of 1862.

From November 1, 1865 to November 1, 1866, the total progress was, however, but 154 feet, which would have been at a little less than an average of thirteen feet per month; but from May 6th to August 1st of this year, the work was entirely stopped to introduce further new machinery, so that it was in motion for only nine and one-fourth months, and made sixteen and two-thirds feet per month. Neither of these two years' operations afford a fair test of further progress, as the introduction of new machinery not only stopped work for the time, but checked it both before and after. The depth sunk in October last was twenty-three feet at upwards of 350 feet down, and I see no reason why a speed of at least twenty feet may not be accomplished, unless water, of which there is now very little in the shaft, should break in abundantly. The firing of the blasts by electricity at the same instant has greatly helped their effect, and promoted the safety of the hands as remarked by the Chief Engineer in his reports. The character of the rock is more favorable here than it has so far proved in the body of the Tunnel, both as to ease of drilling and blasting, and freedom from wet.

West Shaft.—This shaft, as above stated, having been found completed, and headings in both directions begun from it by Haupt & Co., work was commenced in it under the Commissioners in March, 1864, with the contractors' machinery, with which ninety-six feet east and one hundred and thirty feet west headings were driven, when the work was stopped, November

12, to put in the new machinery ordered in the spring of that year.

The shaft was pumped out so as to permit the work to proceed again on the first of January, 1865, and by the fifteenth of February following had advanced twenty-six feet east and thirty-five feet west, when the disturbance among the workmen, described by the Chief Engineer in his report of December 15, 1865, which resulted in the burning of the shaft-house and blacksmiths' shop, compelled a suspension of the work until the buildings and machinery were restored and progress resumed on the fifteenth of May in that year. The total advance previous to that date had been only 122 feet east and 165 feet west from the shaft, or, adding what the contractors had before done, 154 feet east and 190 feet west. The imperfect old machinery and the suspensions occasioned by that cause and the destruction of the new machinery and buildings explain this very slow progress for the first year of the new administration. The work being fairly recommenced on May 15, 1865, has made steady progress since, and on November first of the same year had reached a distance of 367 feet east of the shaft. The headings west of the shaft had been stopped on the second of August of last year, in order to await the sinking of a supplementary shaft, to be spoken of presently, and had, at that date, reached a point 281 feet from the shaft. On the first of November of the present year (1866,) the east heading had arrived at a point 990 feet from the shaft, the west heading remaining stationary, as just mentioned. The progress in the *east* heading was, therefore, during the five and a half months preceding the first of November, 1865, thirty-nine feet per month, while, for the twelve months to November first of the present year, it has been fifty-two feet per month on the average, and during the six months immediately preceding that date the average progress has been sixty-two feet per month, sixty-four feet having been driven in July last. This recent advance in the working from a *shaft* is more rapid than was estimated by any of the engineers who reported in 1862 and who allowed a progress of from thirty-three and one-third feet to forty feet in the shaft headings, excepting Mr. Storrow, who made no difference in the rate from that of an open end heading, putting both at an average of sixty feet per month, and so

far the latest results would show him to have been the nearest right. A fair test, however, of relative speed of advance in the two sorts of working has not yet been had, and, when both are progressing under the circumstances most favorable to each, the headings from the open end will be found to go the fastest. The results in the West Shaft are, however, very encouraging in this as well as every view. The headings in this shaft, both ways, were driven at the bottom of the Tunnel, allowing, however, for drainage, a slight slope towards the shaft in the west heading having been so begun by Haupt & Co. and continued by the Commissioners until, in August, 1865, the *east* heading was raised from the sub-grade (or bottom,) to four and a half feet above that level at which it has since been carried on. These headings, both ways from the West Shaft, at first had a section of six by eleven feet, then enlarged to six by fifteen for their whole lengths, and since farther enlarged to ten and a half by fifteen for a distance of 750 feet eastward and 230 feet westward from the centre of the shaft, from which central point all the above measures are counted. It was in the east heading of this shaft that experiments with nitro-glycerin as an explosive were made, under the direction of Col. T. P. Schaffner, in September last, and with highly favorable results, as reported by the Chief Engineer, who states the forward progress in the heading proper (six by fifteen in section,) as *doubled*, and in the heading enlargement (to ten and a half and fifteen,) as *trebled*, by this new agent when compared with gunpowder. He also reports \$10.20 per cubic yard saved in the heading, and \$3.64 in the enlargement, on a similar comparison with gunpowder, results certainly of the most encouraging character, and inviting to farther and persevering effort for the safe and successful use of the new explosive.

The hoisting machinery at this shaft has operated as well as would be wished since its erection, and the pumps have also performed well up to the limit of their capacity which, when increased by the enlargement of the "plunger," was equal to the raising of about 140 gallons per minute. The quantity of water in the headings has, however, been gradually increasing until within the last month it became so much beyond the ability of the pump as to render necessary a suspension of the work, which must continue until a new pump of much larger

power is introduced or auxiliary means are employed to keep down the additional influx. The latter alternative will be resorted to, as I understand, for the present at least, so as to permit the work to be shortly resumed.

Supplementary Shaft.—The west heading of the West Shaft having been stopped on the second day of August, 1865, for the reasons given by the Chief Engineer in his report of December 15 of that year, the new shaft now referred to was begun on the eleventh of December, 1865, at a distance of about 264 feet west of that shaft. Its depth, when completed, will be 277 feet, and its section 6 by 13 feet, to be divided into two compartments of 6 by 6, with a pump in each. The bottom of this shaft falls *within* the west heading of the West Shaft, so that it will supersede the latter altogether, at least for raising water from the tunnel. The advantages to be derived from it are: 1st, a longer base from which to extend the line of the tunnel eastward, and a test of this line already followed. 2d, a reduction of lift for the water, equal to the difference of 39 feet in the depth of the two shafts, (the West Shaft being 316 feet deep,) increased by a small horizontal driftway, which has been made to perforate the ground 41 feet below the top of the Supplementary Shaft, thus making the whole reduction of lift 80 feet. This driftway is about 100 feet in length, with fall enough at its outer end to carry of the water freely, when raised through the shaft. The Chief Engineer in his present report, which he kindly allowed me to see, has fully explained his motive for sinking the Supplementary Shaft no farther west, where it would have had much less depth. In my report of the twenty-ninth day of October last, I assumed, from its previous progress, that seven or eight months from that date, would probably be required to complete it. At my recent visit to the Tunnel, I was, however, gratified to find that it had progressed so much faster than before, that there remained but sixty-three feet to complete it, and that as it was also being worked upwards from the bottom, it would be finished, probably, in February next. If the auxiliary means for freeing the West Shaft headings from water, above referred to, should not prove sufficient to permit the resumption of work therein, the early completion of this new shaft, to which the machinery should at once be removed, should, in view of the

reduced height to which the water will then have to be raised, allow of the recommencement of the east heading soon thereafter. The Supplementary Shaft has been sunk by contract.

Trial pits and borings, between West Shaft and West End.—

Between the Supplementary Shaft and the West End, four of these pits or wells were sunk on the line of the tunnel, and three of them were continued down, or near to the grade of the road, by borings. The minute description of them by Mr. Doane, in his report of December 15, 1865, with his additional reference to them in his present report, renders unnecessary a more particular account of them here. They all developed facts of interest in regard to the character of the ground to be met with, in executing the part of the Tunnel between the west heading of the West Shaft, and the West End, showing that wet work must be expected; but that rock, although in a soft and saturated condition, will be found throughout the whole distance of two thousand feet. This material, although requiring more than ordinary precaution in drainage, excavation and arching, is more favorable than the dry quicksand and boulders encountered by Haupt & Co., in the work done by them at the West End of the Tunnel, as then established, but since altered by the Commissioners.

West End.—The Chief Engineer in his reports of September 18, 1864, and December 15, 1865, gives a detailed account of the circumstances under which this interesting section of the work was commenced and carried forward to that date. The Commissioners, as appears from their report of February 28, 1863, had decided to move the West Portal nine hundred and eighty-eight feet east of the point at which it had been fixed by Haupt & Co., and so shorten the Tunnel to that extent. This purpose, however, was coupled with the design of raising the grade some twenty-five feet above that on which those contractors had built their work. When, subsequently, it was determined to lift the grade only six feet, the Portal was placed as would appear from the profile furnished me by Mr. Doane, about three hundred and sixty-four feet *west* of the point selected by the Commissioners, and six hundred and twenty-four feet *east* of the portal of the contractors' tunnel. The fourteen months

elapsing from the passage of the work into the hands of the Commonwealth, up to December, 1864, were occupied in excavating as an open cut, the difficult and treacherous ground lying immediately east of the abandoned work of Haupt & Co. A heading was then begun in the soft rock which had been reached, and carried forward about one hundred and thirty-nine feet, but as it caved in at the forward end, up to the surface of the ground, it was suspended, and time taken to consider the best means of proceeding farther with the work, involving, as it did, the progress of the Tunnel through the long distance of doubtful material all the way to the west heading of the West Shaft. The working season of 1865, and the spring of 1866, passed in sloping and securing, by retaining walls, the open cutting; and a contract was then made with Mr. B. N. Farren, for arching one hundred and seventy-four feet of the Tunnel, from the West Portal, eastward to where the open cut, in which this section of the work was to be built, and afterwards filled over, came to an end, and drifting under ground, would again begin. The contract farther provided, that at least two hundred feet more arching should be done east of this point, and of course, as a subterranean work, on or before June 30, 1867.

Work was commenced under this contract on June 7, 1866, and by the end of November, ultimo, the open cut part of the arch was brought up to the breast, and the brickwork, at my recent visit, had fairly entered the drift in which it is hereafter to advance eastward. Some months ago, a heading had been carried about 40 feet into the hill from this breast. Its position was at the top of the section of the Tunnel, and as the ground proved wet and difficult as it advanced, another and smaller drift was driven underneath at the bottom of the section, and pushed some 80 feet inwards, with a view to drainage. From the end of this last drift, two lateral and smaller drifts have been carried forward, curving outwards at first, so as to clear the Tunnel area, and afterwards proceeding in lines parallel to the line of the Tunnel, and about 15 feet therefrom. The southerly one of these drifts has penetrated about 220 feet eastward from the breast above mentioned, and the northerly one more than half that distance. They disclose wet ground, consisting of soft rock, mostly saturated with water. Their purpose has been to cut off the springs on either side from the

Tunnel area, so as to dry the latter as far as possible, and facilitate the drifting and arching. The aggregate discharge of water from these draining drifts, as roughly gauged in October last, was about 70 gallons per minute; but is probably more at this time, and may increase to much more still during the coming winter and spring, from snow and rain.

The contractor is pushing his work forward, supporting the roof and sides of the excavation, by timbering in the manner usually adopted in such tunnelling, and having experienced miners to direct the work in detail, is making pretty fair progress. From present appearances it would seem that a "shield" on the plan alluded to in my report of October 29th, may be dispensed with; and if so, the work can proceed more rapidly and cheaply on the method now in operation, or some improvement on it hereafter to be devised.

Road between the Tunnel and the Village of North Adams. This part of the road has been surveyed on two lines diverging near the West End of the approach, cut and reuniting about half way from thence to the site of the station grounds in the village. They differ very little in length, (only 34 feet;) the most southerly is the most direct, while the other, although with more curvature, requires about 94,000 cubic yards less of embankment upon it, and will do much less injury to the farms intersected. The excavation in the approach cut, and in the Tunnel, applicable to the embankment westward, will more than make it on the northern line, but will fall considerably short of so doing on the southern line. The northern line will thus be found considerably the cheaper; and, although not quite so straight and handsome a line, will, I doubt not, obtain the preference when a final location comes to be required. Such a location should not be much longer postponed, as land is rising in value, and especially within the village of North Adams; the line should be fixed, station grounds selected, and right of way secured, as improvements are growing up daily which will greatly increase the expense of this item. In the report I had the honor to make on the 31st of August last, I called attention to this subject, and, having concurred with the Chief Engineer as to the proper line through the village and the best site for the station, I had regarded these questions as settled,

and, in this impression, I believe the Commissioners are also agreed.

I have availed of the present occasion to give the preceding history of operations at the Tunnel since the Commissioners took charge of them three years since, believing that a connected narrative, gathered from the periodical reports, would not be unacceptable at this time, and especially as it will enable me more conveniently to refer to the past experience of the work in expressing my views as to its future conduct. Before proceeding however to submit the opinions I have been led to form in this regard, I will speak briefly of the

COST OF THE WORK TO THE PRESENT DATE.

First, Cost of the Road between Greenfield and the Tunnel.—The documents in my possession do not give me the means of stating the cost of the 30 miles of road east of the Tunnel, or of the Tunnel itself, prior to their passage into the hands of the Commissioners, from those of the contractors, Messrs. Haupt & Company, in October, 1863. No work having been done (until very recently under the new contract,) under the Commissioners on the road east of the Tunnel, I can only refer to the *estimate* in their first report of February 28, 1863, wherein (page 32,) they put the expenditure required to open the road from Greenfield to the Tunnel at \$497,061 — to which they add \$75,000 for rolling stock required to work it — making a total of \$572,061. As the contract executed in October last with Mr. Farren provides for the completion of this division of the road at a sum within this estimate, and the lease of the road to the Fitchburg Railroad Company and the Vermont and Massachusetts Railroad Company, obviates the necessity of any outlay on the part of the Commonwealth for rolling stock, this item of expenditure under the Commission may be considered as liquidated.

Cost of the Tunnel.—Confining, as explained above, my statements under this head to the expenditures by the Commissioners, I have before me an abstract of those expenditures, from their commencement in October, 1863, up to November 1, 1866, which I have classified as follows in accordance with the division of them in his annual report to the Commissioners,

by Thomas Doane, Esq., Chief Engineer, through whose kindness I have been furnished by them. The items treated by him as "buildings, machinery, fixtures, &c., not really spent, but available for further use," I call "outside;" and those "really spent in the work and of no further use except as they constitute a part of the expense necessary in constructing the Tunnel"—I call "*inside*" expenses. It will be seen that the former class bears a very large proportion to the latter *thus far*, amounting, indeed, to nearly one-half of the whole expenditure—a fact which may naturally surprise and even startle at the first glance, and before the great magnitude of the work and the small part of it *yet done* is properly considered.

EXPENDITURES UNDER COMMISSIONERS ON HOOSAC TUNNEL.

I.—*Outside Expenditure.*

Deerfield Dam,	\$244,912 29	
Buildings, East End,	\$31,688 99	
Buildings, West End and West Shaft,	40,010 13	
Central Shaft,	12,026 83	
General amount,	9,537 37	
	<hr/>	93,263 32
Machinery, East End,	\$87,032 38	
Machinery, West End,	539 89	
West Shaft,	57,111 73	
Central Shaft,	51,364 01	
Deerfield Dam,	10,820 93	
General accounts,	62,600 76	
	<hr/>	269,469 70
Land Damages and Land,	17,513 21	
Engineering and Superintendence,	84,840 48	
Total Outside Expenditure,	<hr/>	\$709,999 00

II.—*Inside Expenditure.*

East End Heading,	\$103,731 45	
E. End H'd'g Enlargement,	17,559 46	
E. End Bottom Enlargement,	80,317 10	
	<hr/>	\$291,608 01
Central Shaft,	144,423 75	
West Shaft, Headings, &c.,	179,041 69	
West End, Approach Cut, Drifting and Arching,	247,900 75	
Total Inside Expenditure,	<hr/>	772,974 20
	<hr/>	
Total Expenditure to November 1st, 1866,		\$1,482,973 20

To be enabled to judge whether the expenditure above stated bears a proper relation to the amount of work not only already done, but to be done hereafter, we must, of course, know what that amount in fact is, and will be, when the work is completed ; nor is it less necessary to consider all the circumstances which have affected the past and may affect the future cost of the work. I am not as yet provided with the particulars of the work either done or to be done, expressed in the usual measures of quantity, and although I have made approximate estimates thereof, I hesitate to apply them to the work *already done*. I deem it, then, prudent to say only thus much as to the cost *per cubic yard* of the work done in the Tunnel and Central Shaft *thus far*. 1st. That it would manifestly not be fair to charge it with the whole expense of the *outside* work, as that must be divided among the entire number of cubic yards in the Tunnel and shaft *when completed*. 2d. That it would neither be fair to estimate the cost of future work by what the work now done has cost per cubic yard up to this time on the basis of the *inside* expenditure alone. The many embarrassments and difficulties attendant upon the commencement of a work of such unprecedented extent, and in some respects novel character, and upon the control of so large a body of operatives in a remote and thinly settled region, the excessive cost of labor, and the often insufficient supply of the sort most wanted, the delays in procuring the machinery and material for making the manual labor most effective, the heavy expense of transportation between different parts of the work over such a mountain and such roads, these and other circumstances afford, in a good degree at least, an explanation of what has undoubtedly been an unusually large expenditure in comparison with the results obtained so far. To this we may add the almost invariable and inevitable excess of cost in work done by the day over that done by contract, especially on so large a scale as the present. With these general remarks as to the cost of the work already done, and begging leave to refer to the Commissioners for more detailed statements under this head, I would proceed to speak of the probable cost of *completing* the work from this time out, in connection with such suggestions as I have respectfully to offer as to the mode of conducting it in the future.

FUTURE PROGRESS OF THE WORK AND RECOMMENDATIONS WITH
A VIEW TO INCREASED SPEED AND ECONOMY.

I would commence what I have to say under this head, by remarking that whatever opinions may be entertained as to a part of the system of machinery employed to carry on the work, (the Deerfield dam for instance,) it must be admitted that the structures and machines themselves are of the best construction of their respective kinds, and that they have performed their duty efficiently. It is true that more pumping power is now urgently required at the West Shaft, and that more will also be probably needed at the Central Shaft as it sinks, and more hoisting power necessary when it reaches the grade of the Tunnel, and tunnelling from it begins. It would be well indeed if the excess of power furnished by the Deerfield dam could be made effective at the Central and West Shafts, but that not being practicable, these points must be otherwise provided for, as their wants require. This provision will not involve a very heavy outlay, and when made it will close the machinery account. I would now recommend the following changes in the plan and mode of carrying on the work hereafter.

1st. Slight Change of Grade in the Tunnel.

The grades within the Tunnel, as now arranged, are about as follows: From the East Portal to the Central Shaft, a distance of 12,821 feet, (2.428 miles,) the ascent is at the rate of $18\frac{1}{2}$ feet per mile. A level then extends about 1,390 feet (.263 of a mile,) from the Central Shaft westward, and from its termination the descent for 8,336 feet (1.584 miles,) is at the rate of $21\frac{1}{8}$ feet per mile to the West Shaft, whence for 2,284 feet (.432 of a mile,) to the West Portal, the descent is $26\frac{1}{2}$ feet per mile—the two portals being precisely at the same height of 766 feet above tide-water. I would propose to modify this grade to the following extent, viz.: From the East Portal ascend at $21\frac{1}{8}$ feet per mile to the Central Shaft. A level of 898 feet long from thence westward, and then a descent of $23\frac{3}{4}$ feet per mile, to the West Shaft and a junction with the present grade thereat, whence to the West Portal the existing grade of $26\frac{1}{2}$ feet per mile would remain unaltered. I would have proposed a more decided change in the grades, but for the restraint imposed by the work already done, and which will be very

slightly affected by the alteration now suggested. The advantages to accrue from the change will be a more rapid drainage in each direction, resulting from the stronger slope both ways, and the shortening of the summit level. The steepening of the grade on the east side of the summit so as to insure the downward passage of the trains by gravitation, and without the use of steam and consequent evolution of smoke—the cutting off about $6\frac{1}{2}$ feet from the depth of the Central Shaft. The last item is not of much account, and is mentioned only as incidental to the others. I attach considerable importance, however, to the two first items, as a free escape of water from the Tunnel will tend to lessen the dampness so prejudicial to the adhesion of the locomotives—and as the large preponderance in freight will be in the eastward direction, and hence much the most tractive power required to draw the trains that way, it is desirable to give them all practicable assistance in their passage, for the descent of a train by gravity alone, along a grade of $18\frac{1}{2}$ feet per mile, requires a reduction of friction in the cars within the usual limit, while a grade $21\frac{1}{8}$ feet per mile, will usually give motion without other motive power. A grade of $26\frac{1}{2}$ feet per mile, I should have preferred, but on examining carefully the effect of its adoption at the East End on the work done there, I concluded to compromise upon the lesser one. As from the West Portal to the shaft, the grade is already established beyond change at $26\frac{1}{2}$ feet per mile, ascending eastward against the heavy trade, the gentler of $23\frac{3}{4}$ in the same direction cannot be objected to.

2. *Enlargement of Tunnel, and Change of Position of Heading.*

I advise that the enlargement of the Tunnel be at once commenced, both at the East End and the West Shaft, in the eastward direction, and that the headings be suspended until the full section of the Tunnel is taken out quite up to them; that the position of the headings be then changed from their present level of four and a half feet above the grade to about fifteen feet above grade, with a height of seven feet at the crown of the arch, and fifteen feet width, the whole depth of the section being assumed at twenty-two feet, and width, at chord-line of semi-circular roof, twenty-five feet, and at grade or bottom, twenty-three feet, with an area of fifty-six and six-tenths square

yards. In the progress of the work thereafter, should this change of plan be adopted, I would recommend that the bottoming be kept as close to the heading as may consist with convenience and safety. If hand labor be used in the heading, it can be worked within fifty feet of the bottom, or even less, (a proper slope being allowed between the two,) as the purpose of the heading as an advanced opening into the rock, would be as fully answered as if it were an indefinitely greater distance forward. If machine drills be employed, the heading must be kept considerably farther in advance, in order to allow the drill carriages to be run back out of the way of blasts. My reasons for the preceding recommendations are stated briefly thus :

The position of the heading at the top of the Tunnel section will avoid the use of scaffolding in the enlargement ; will be attended with less injury to the tracks from the fall of the rock when thrown out by blasts ; will cheapen the drilling by permitting the holes (in the bottom or enlargement,) to be made vertical, thus relieving both the holder and striker, and will make the force of the powder in this highly inclined stratification more effective ; will save expense in *trimming*, which, with the heading at the bottom, must be done *twice*, first to the temporary and afterwards to the permanent roof ; will allow the bottom enlargement to be kept up much closer to the heading, especially if the drilling is done by hand. It will thus save much handling of material. It will also help ventilation by keeping the section of the Tunnel its full size, and giving room in its upper portion, where no work is doing, for the smoke in most conditions of the atmosphere. It will permit a double track of the ordinary gauge and cars of the full size to come near the breast and receive their loads without so much obstruction from fragments of rock. If the roof should prove unsound at any point, the fact is at once discovered, and means adopted to support without interference with the subsequent enlargement or disturbance of the props introduced.

The arguments in favor of the heading at or near the bottom, do not, in my opinion, balance those on the other side. It is true that the weight of the rock in enlarging at the top assists the force of the explosive in blasting ; but the claim of better drainage with the bottom heading is not well founded, as the

central drain can as well or better be opened and maintained in the enlarged section when the heading is at the top. The continuity of the tracks in the bottom heading would be of advantage only in case the small cars used in the heading were run all the way out to the Portal, which would be bad economy. It is better to bring up the large cars and shift the load of the small cars into them, which can better be done by dumping from a higher level than lifting from a lower one, the inconvenience of which is noticed in Mr. Storrow's report on the Mt. Cenis Tunnel. The objection to the top heading, that its material has to be thrown down over the fall of the enlargement breast, may be obviated by proper dumping arrangements, if the heading were so far ahead of the bottom as to make the use of small cars necessary. The two workings, however, if by hand, should be kept so close that, the blasts being all fired at once, most of the heading material will be thrown over the breast by the force of the explosion, and what remains can be thrown over by hand when the men are at meals. The reason in favor of the bottom heading, on which most stress has been laid, is the supposed facility it would afford for carrying on the enlargement at a number of points, supposing the heading to be completed altogether in advance of the enlargement. If the heading were in fact so driven through in advance, it would be at a greatly increased cost of ventilation, drainage and effective force of the blasts, as well as of transportation, which would have to be done altogether in small cars. But it is not considered as really practicable so to conduct the enlargement, as the small section of the heading, the crowded condition of the work therein, the narrow tracks, small cars, bad ventilation and drainage and obstruction to the tracks from fallen rock, interference with each by passing cars, &c., would produce inextricable confusion, and so reduce the transportation facilities as to make the plan incapable of execution. The saving of *interest*, by thus putting off the expense of enlargement, would not compensate for the other disadvantages of the plan. Indeed, as, with the heading at the top, the whole section of the Tunnel can be carried on *pari passu*, the very earliest possible opening of the whole work can be thus accomplished, and its commercial advantages, the main motives to its construction, soonest realized. The popular

favor to be won by proclaiming that "the mountain had been pierced through and through," would be a very ephemeral and unsubstantial set-off to the after-claps which would come in the almost insurmountable difficulties of the enlargement, without which enlargement the mere "hole in the hill" would be worth nothing, and but an empty boast. The true foundation for favorable reports of the progress of the work to the legislature and the public would be the number of cubic yards taken out, and the tunnel so far finished and ready for use at each step of its advance. I would therefore earnestly recommend that *this* plan be pursued in the further prosecution of the work.

3. *Central Shaft.*

I have only to say of this that its vigorous prosecution should be uninterrupted, with its present effective machinery, assisted by such additions as may be found necessary hereafter, when the Tunnel is reached, and increased means of ventilation, drainage and transportation are required.

West Shaft.—The enlargement at the West Shaft, above advised, in the eastward direction, should also be proceeded with in its westward working, so that when the Supplementary Shaft is completed, and the pumping and (if there be room for it,) the hoisting machinery removed to it from the West Shaft, the Tunnel may be driven westward from the new shaft to meet the eastern working from the West End, which should be advanced as far as practicable, in order to get rid of the expense of raising water and material from this shaft.

West End.—The only recommendation I have to make, in connection with this part of the work is, that it be steadily advanced at the best speed which its peculiar difficulties will admit of. I am not sure that the use of a cast-iron arch, applied in a manner suited to the case, would both hasten and cheapen the work here, and I propose to give particular attention to it on my next visit to the Tunnel. There will be time to mature any such improvement in plan before the contractor will have carried the brick arch to the limit provided for in his agreement.

EXTENSION OF THE CONTRACT SYSTEM TO THE REMAINDER OF
THE WORK.

Under this head, I would prefer at present to suggest inquiry, rather than offer positive recommendation, (although I decidedly favor the policy,) and as the Commissioners have the subject under consideration, it will be as well to leave it in their hands. I cannot but believe that as the work is now, or shortly will be, situated, it may be so divided as to let out to individuals, or firms of contractors, at stipulated prices, with advantage in many ways. The number of the divisions would naturally be *four*, viz., the *East End*, the *Central Shaft*, the *West Shaft*, and the *workings both ways from it*, and the *West End*, with its approach cut and the mile of road between the Tunnel and North Adams nearest the Tunnel, as its embankment would be made from that cut and the Tunnel. The mile of road next to and through North Adams, needs only to have the right of way and station grounds on it secured for some time to come. The detached position of the several divisions of the work above mentioned would permit them to be carried on under separate contracts. They could not, however, be further sub-divided without danger of collisions. If general competition were invited, the work could be let at reasonable prices, and this remark leads me to speak of the

PROBABLE TIME OF COMPLETION, AND COST OF THE WORK.

Estimates both of time and cost, in a case like the present, must be offered with some degree of reserve; yet I do not feel much hesitation in submitting the following opinions as to the period at which the completion of this great work may be reasonably looked for; and as to the amount which should suffice to finish it:—

1st. Time necessary to complete the Tunnel.

An inspection of the profile of the Tunnel and approaches, shows that the mountain has been penetrated from the *East End* to a distance in round figures of 3,500 feet; from the *West Shaft*, eastward, 1,000 feet, and westward, 280 feet; and from the *West End*, about 180 feet of arched tunnel has been

constructed. The Central Shaft has been sunk, we may say, 390 feet at this date. As the whole length of the Tunnel, from its eastern to its western Portal, is 24,862 feet, and work has been done upon 4,960 feet, there remain 19,902 feet, linear, on which nothing has been done in the line of the Tunnel, and as the Central Shaft, when sunk to grade, will be 1,030 feet deep, (supposing the change of grade suggested above be made,) there remain 640 feet untouched in this shaft.

If the change in the manner of carrying on the work above suggested be adopted, and the headings be suspended until the enlargement be brought up to them, the time required for these enlargements must first be fixed. To do this, the number of cubic yards to be removed must be estimated, and in computing this (approximately) from the data I have at hand, I will assume, for the present purpose, (although it is a little larger than the size above mentioned,) the area of the completed Tunnel when executed in rock, without allowance for lining with brick or stone, to be 54 square yards, which I judge to be very nearly the section proposed by the Chief Engineer in his report of December 15, 1865, (page 29.) There will then be 18 cubic yards for every linear foot of the Tunnel.

East End.—3,500 feet linear, at 18 cubic yards
per foot, 63,000 c. yds.

From this take Haupt & Co's.

work, estimated at, say, . 17,000 c. yds.

And Commonwealth's work,

estimated at, say, . . . 9,000 "

26,000 "

Which leaves to be taken out in enlargement, 37,000 c. yds.

If now we allow $\frac{3}{4}$ of a cubic yard to represent the day's work of each man employed in this part of the Tunnel, and 250 men to be the average force, there would be $187\frac{1}{2}$ cubic yards removed per day, and the whole 37,000 yards in 200 working days; or say eight months of 25 days, to complete the East End enlargement.

<i>West Shaft, Eastward.</i> —1,000 feet, linear, at	
18 c. yds. pr. foot,	18,000 c. yds.
<i>West Shaft, Westward.</i> —280 feet, linear, at	
18 c. yds. pr. foot,	5,040 “
Making 1,280 feet, linear, at 18 c. yds. _____	
pr. foot,	23,040 “
From this take Haupt & Co's work,	
say,	300 c. yds,
And Commonwealth's work, say, 5,700 “	
_____	6,000 “
Which leaves to be taken out in enlargement, _____	
	17,040 c. yds.

And at $\frac{2}{16}$ of a cubic yard per man per day, and an average force of 100 men, the time required to complete the enlargement of this division of the Tunnel, 300 working days, or say 12 months.

Central Shaft.—There remains of this shaft to be sunk 640 feet, which, at 20 feet per month, will take 32 months to reach the floor of the Tunnel.

West End.—It is not easy to assign a rate of progress for this part of the work, as unexpected difficulties may retard it, but 35 feet per month should be a safe estimate of its advance, and this rate will also be assumed for the west working of the West Shaft. Upon the above data, we can see where the several parts of the work will be at certain dates, counting, we will say, from the 1st of January, 1867, now at hand.

September 1, 1867.—If eight months be sufficient to complete the *East End* enlargement, on September 1, 1867, it should be done, and the heading and enlargement ready on that date, to go forward together. The *Central Shaft* on the same date will, at 20 feet per month, have made 160 feet down, and have 480 feet to go down to grade.

The *West Shaft* enlargement will be two-thirds completed. The *West End* drifting and arching will have advanced 280 feet eastward, and to a distance of 460 feet from the West Portal.

January 1, 1868.—If we allow 65 feet per month for the progress of the *East End* work, it will at this date have moved 260 feet westward, and have reached 3,760 feet from the East Portal.

The *Central Shaft* will be 80 feet farther down, and have only 400 feet to go. The *West Shaft enlargement* in both directions, will be finished. The *West End arch* will have moved 140 feet east, and made a total progress of 600 feet, from the West Portal.

September 1, 1869.—*East End* work advance in the 20 months since the previous date, 1,300 feet.

Central Shaft down to grade and ready to tunnel both ways. *West Shaft, eastward*, work, at say 48 feet per month, will have gone 960 feet, and its *westward* work at 35 feet per month, 700 feet. *West End arch* will at the same rate of 35 feet per month, have also advanced 700 feet eastward, and a total distance of 1,300 feet from the West Portal. These two workings will meet at this time.

July 1, 1875.—*East End* work in the five years and ten months since the last date, will have progressed (at a fraction less than 60 feet per month,) 4,611 feet westward. *Central Shaft, east*, working at 45 feet per month, will have advanced eastward, a distance of 3,150 feet, and have met the work from East End, and consequently, completed the Tunnel east of this shaft. *West* working of Central Shaft will, at 45 feet per month, have advanced westward 3,150 feet at this date. *West Shaft, east* working. Inasmuch as the Tunnel as above stated should be opened through from the West Portal to this working, on September 1, 1869, a rate of progress fully equal to that of the East End will then be realized from that date onward; and in the $5\frac{1}{2}$ years from September 1, 1869, to July 1, 1875, a fraction over 66 feet per month will make it meet the west working from the Central Shaft, and so complete the Tunnel.

In these estimates of time, I have assumed hand labor to be the agent, and I feel fully warranted in allowing the several rates of speed in the several workings, from which the result is deduced, that the Tunnel can be finished in eight and one-half years, from January 1, 1867. If I have allowed somewhat too short a time for the enlargement of the present work at the East End, there is margin enough in the other estimates of progress to make up for this deficiency. Increase of speed

from the drilling machine, and the use of nitro-glycerin, may largely increase this margin.

PROBABLE COST OF THE WORK TO BE DONE.

If the contract system be applied to the several divisions of the work as above suggested, I am of opinion that with the effective machinery already furnished by the State, with such additions at the Central and West Shafts as may be required, and with proper competition between able and experienced contractors, the work can be let at prices which will produce results as favorable as the following estimate exhibits. It will require probably two months from now to reorganize the work on this new contract basis; but as, if my recommendations in regard to changes in the manner of prosecuting the work be adopted, the enlargement could be commenced immediately, I will assume for simplicity's sake the same prices for what work may be done by the Commonwealth in the interim.

The area of the Tunnel *in rock*, requiring no lining, will, as above, be taken at 54 square yards, for the purpose of this estimate, or at 18 cubic yards per foot, linear. As it is not possible at this time to say how much beyond the west heading of the West Shaft the Tunnel can be carried through rock not needing support, I will assume that an arch of brick or stone will be wanted for its protection for the whole distance west of that heading; but as the lining will not probably be so costly for some distance beyond that point, I will not apply the same price throughout this section of the Tunnel. I will estimate this part of the work by the linear foot (and not by the cubic yard,) having reference to the prices now paid the contractor, who is carrying it on for a part of the distance.

The whole length of the Tunnel between the Portals being, say, 24,862 feet, or $4\frac{709}{1000}$ miles, and the length assumed to require arching, being 2,004 feet at the West End, there will remain 22,858 feet, which, at 18 cubic yards per foot, give 411,444 cubic yds.

From this deduct the cubic yards already

removed, and amounting as above ap-

proximately estimated, to 32,000 “

Leaving to be removed from the body of

the tunnel, 379,444 “

Of which the enlargement now ready to be
made contains, 54,000 cubic yds.

Leaving in the untouched part of the tun'l, 325,444 “

Different prices will, of course, be applied to these two last items, but an average price will be taken for the heading and bottoming in the unbroken part of the Tunnel.

ESTIMATE OF COST.

54,000 cubic yards in enlargements at \$5, .	\$270,000 00
325,000 “ “ heading and bottom, at an average of \$7.50,	2,437,500 00
7,538 c. y'ds in remainder of c'ntal shaft, \$30,	226,140 00
1,000 ft. linear at west end, next portal, \$400,	400,000 00
1,000 “ “ “ “ shaft, \$300,	300,000 00
	<hr/>
	\$3,633,640 00

Making three million six hundred thirty-three thousand six hundred and forty dollars.

I add nothing for *contingencies*, because in estimates of this description, the prices assumed are not sufficiently *exact* in their character as to make such allowance necessary, or rather the contingencies are supposed to be covered by the prices. The contingencies affecting this particular work are, indeed, with our present experience of its nature, not of a very doubtful or indefinite kind. We know well now what sort of rock we have to blast, and the only serious question is, how much or how little water must we pump out of the two shafts? It is my belief that the work can be let to responsible contractors for the prices above assumed, and that is all that can be said at the present. They bear a fair relation to the prices prevailing before the war, and the suspension of specie payments, and with the prospect of a gradual return to such payments, and consequently a general reduction in the values of labor and material, I think they will be regarded as sufficient by parties bidding for the work, and who will necessarily, for work of such magnitude, be of the most experienced and judicious class.

CONCLUSION.

It is my hope that what I have above presented may be considered as a sufficient performance on this occasion of my duty as your Consulting Engineer. It was my wish to have submitted, in addition, some remarks upon the character and value of this great work, as a part of the railway system of the Commonwealth, but time will not permit me at present to say more than that, in view of its unparalleled magnitude and consequent cost, it should not be considered *by itself*, but in connection, not only with the entire line of which it forms a part within the State of Massachusetts, but as a necessary link in a chain of interior communication, extending even to the most distant source of trade to the Commonwealth and her capital. If viewed in this light, the extraordinary expense involved in this monument of State enterprise and laudable State pride, will be lost sight of, except as another example of what Massachusetts can do when she is determined.

Most respectfully, your obedient servant,

BENJ. H. LATROBE,
Consulting Engineer.





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REPORT OF THE COMMISSIONERS

UPON THE

TROY AND GREENFIELD RAILROAD

AND

HOOSAC TUNNEL.

BOSTON:

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Commonwealth of Massachusetts.

EXECUTIVE DEPARTMENT, BOSTON, }
March 22, 1869. }

To the Honorable Senate and House of Representatives :

I have the honor to transmit herewith, for the information of the General Court, a Report of the Commissioners upon the Troy and Greenfield Railroad and Hoosac Tunnel.

WILLIAM CLAFLIN.

Commonwealth of Massachusetts.

COMMISSIONERS' REPORT.

To His Excellency the Governor, and the Honorable the Executive Council of the Commonwealth of Massachusetts.

The Commissioners of the Troy and Greenfield Railroad and Hoosac Tunnel, for the year 1868, respectfully submit the following

REPORT:

The Act to incorporate the Troy and Greenfield Railroad Company, giving authority to construct and maintain a railroad, with one or more tracks, from some point on the Vermont and Massachusetts Railroad at or near the termination of said railroad in Greenfield, to some point on the line of the State of New York or Vermont, convenient to meet or connect with any railroad that may be constructed from any point at or near Troy, on the Hudson River, in the State of New York, was passed May 10th, 1848. The capital stock of the company was limited to \$3,500,000, in shares of one hundred dollars each.

It appears from the records of the Troy and Greenfield Railroad Company that as early as 1850, measures were taken to extend the line of railroad west from the State line by procuring a charter from the General Assembly of Vermont for the Southern Vermont Railroad Company and consolidating the two corporations; and June 12, 1851, it was voted, "that the road through Pownal be commenced whenever the Troy and Boston Railroad Company commence their road from Hoosac Falls to the state line of Vermont."

By an Act passed May 20, 1862, the Troy and Greenfield Railroad Company was authorized to unite with the Southern

Vermont Railroad Company so as to form one company by the name of the Troy and Greenfield Railroad Company.

In 1854, the Commonwealth, to enable the Troy and Greenfield Railroad Company to construct the Hoosac Tunnel, loaned its credit to that company to the amount of two million dollars. By this Act the tunnel was located in some place between the "Great Bend" in Deerfield River in the town of Florida, at the base of Hoosac Mountain on the east, and the base of the western side of the mountain near the east end of the village of North Adams on the west. And one hundred thousand dollars of the State scrip, the first issue of the two million, was to be delivered to the treasurer of said company when said company had obtained subscriptions to their corporate stock in the sum of six hundred thousand dollars, upon each and every share of which twenty per cent. had been actually paid in, and had completed seven miles of their said railroad, in one or two sections, and one thousand lineal feet of their said tunnel under the Hoosac, in one or more sections, of size sufficient for one or more railroad tracks. This Act created a sinking fund of which the auditor of the Commonwealth and the treasurer of the Troy and Greenfield Railroad Company were made commissioners.

In 1855 the several towns of Ashfield, Buckland, Conway, Coleraine, Charlemont, Deerfield, Greenfield, Hawley, Heath, Monroe, Rowe, Shelburne, in the county of Franklin, and Adams, Florida and Williamstown, in Berkshire, were authorized each to subscribe for and hold shares in the capital stock of the Troy and Greenfield Railroad Company to any amount not exceeding three per centum on the amount of its last valuation; provided two-thirds of the inhabitants at a legal meeting called for the purpose shall so vote.

Under this authority, (chapter 394 of the Acts 1855,) the town of Adams voted, April 5, 1858, to subscribe for six hundred shares; the town of Williamstown, April 9, 1858, for three hundred and thirty shares, and issued and delivered their scrip for the respective amounts, under conditions which will be hereafter stated. In the case of both towns the scrip matures in thirty years from the date of issue and bears an interest of six per cent. per annum. The town of Greenfield, July 6, 1859, voted to "subscribe to the capital stock of the

Troy and Greenfield Railroad Company to the extent of three hundred shares of one hundred dollars each," and on the 15th of July, 1860, fifteen bonds of \$500 each, dated Jan. 1, 1860, and payable in thirty years, with interest at six per cent. per annum, were issued in accordance with the subscription; and on the 3d of January, 1861, thirty bonds of \$500 each, payable in thirty years, with interest annually at six per cent., were likewise issued, making an issue of \$22,500. The remaining \$7,500 were not delivered over to the company. The town of Shelburne voted June 8, —, to subscribe \$12,000 to the capital stock of the Troy and Greenfield Railroad Company. It issued, however, but \$6,000 in bonds. The town of Buckland subscribed for fifty shares and issued bonds therefor to the amount of \$5,000, upon which it is now paying interest at six per cent. annually. The towns of Ashfield, Conway, Coleraine, Charlemont, Deerfield, Florida, Hawley, Heath, Monroe and Rowe, did not subscribe for any portion of the stock, as appears from the respective reports of their treasurers.

The connection of the several towns subscribing to the stock of the Troy and Greenfield Railroad Company with this corporation, will be referred to in another part of this Report.

The Act of 1854 was modified by chapter 117 of the laws of 1859, and by chapter 202 of the Acts of 1860. By the law last mentioned, the Troy and Greenfield Railroad Company was directed to purchase the entire road, franchise, stock, bonds and other property of the Southern Vermont Railroad Company, together with the income, benefits and reversion of its lease to the Troy and Boston Railroad Company, for the sum of two hundred thousand dollars.

By the recitals in this Act, it appears that at the time of its passage the said Southern Vermont Railroad was mortgaged to secure the payment of bonds to the amount of one hundred and fifty thousand dollars, payable in twenty years from the date of issue, with six per cent. interest, payable semi-annually at the Bank of Commerce in the city of New York; and was also leased to the Troy and Boston Railroad Company for and during the term of the continuance of its charter, at the annual rent of twelve thousand dollars.

The Act requires that the semi-annual payments of the coupons attached to the bonds, "with the balance of the income

from the lease of the Southern Vermont Railroad, shall be collected by or paid to the State treasurer, who shall therefrom pay the interest on the two hundred thousand dollars of five per cent. scrip herein authorized to be issued, and shall pay the balance to the commissioners of the sinking fund of the Troy and Greenfield Railroad loan." The Act also directed that the Troy and Greenfield Railroad should forthwith make and file in the proper offices, a location of their road and tunnel, and prescribed that the grade of any part of their road hereafter to be constructed should "not exceed forty feet to the mile ascending eastward, and fifty feet ascending westward; and that the limits of grade and curvature of said road, included in said location and not graded, should be such that the maximum resistance to the passage of trains in either direction should not exceed the maximum resistance in the same direction as the Fitchburg and Massachusetts Railroads."

TITLE OF THE COMMONWEALTH TO THE RAILROAD FROM NEW YORK LINE TO GREENFIELD.

On the 21st day of April, 1860, the Southern Vermont Railroad Company, by R. Carpenter, Jr., Henry Cartwright and H. Haupt, agents of the same, conveyed by deed to the Troy and Greenfield Railroad Company, for the consideration of two hundred thousand dollars, the "entire railroad" of the Southern Vermont Railroad Company, "extending from its junction with the Troy and Boston Railroad at the State line of New York through the town of Pownal in the county of Bennington and State of Vermont to its junction with the Troy and Greenfield Railroad at the State line of Massachusetts, and all the lands, depots, buildings, structures and other property of said grantor corporation, including the lease made by the said grantor corporation to the Troy and Boston Railroad Company, dated the twenty-first day of November in the year one thousand eight hundred and fifty-six."

The legislature of the State of Vermont, by an Act passed November 10, 1860, "authorized the Troy and Greenfield Railroad Company to hold, use and enjoy the franchise, railroad and property so purchased, subject to the provisions of the ninth, tenth, eleventh, twelfth, thirteenth, fourteenth, twenty-third, twenty-fifth, twenty-sixth, twenty-seventh, twenty-eighth

and twenty-ninth sections of an Act of the general assembly of Vermont, approved November 13, 1848, entitled an Act to incorporate the Southern Vermont Railroad Company." The Act provides that the sections above named "shall have force and apply to the Troy and Greenfield Railroad Company so far as it respects its franchise, railroad and property within Vermont; and that the directors of said company shall appoint an agent, on whom process may be served, who shall reside in Vermont, and whose appointment shall be recorded in the office of the clerk of the town of Pownal in the county of Bennington." Previous to the passage of this Act by the General Assembly of the State of Vermont, to wit, on the 21st day of April, 1860, being the day of the above described purchase of the Southern Vermont Railroad, the Troy and Greenfield Railroad Company in consideration of two hundred thousand dollars, by Henry L. Sabin, Harvey Arnold and Herman Haupt, a committee duly authorized, conveyed in mortgage the Southern Vermont Railroad to the Commonwealth of Massachusetts, and in the first section of the Act last above mentioned "authority is granted to the Troy and Greenfield Railroad Company * * * to purchase, hold and mortgage to the State of Massachusetts the franchise, railroad and property of the Southern Vermont Railroad Company. * * * And all sales, conveyances, transfers and mortgages heretofore made by the Southern Vermont Railroad Company, or by either of said companies, to the State of Massachusetts, are hereby ratified and confirmed."

On the 28th of July, A. D. 1855, the Troy and Greenfield Railroad Company, by "Otis Clapp, Wm. A. Galbraith and Wendell T. Davis, treasurer," executed a bond to the Commonwealth to secure the two million dollars authorized to be loaned by the 226th chapter of the laws of 1854, and on the same day made a mortgage to the Commonwealth of "the entire railroad of said corporation, and its franchises, income and property." The mortgage also conveyed all the interest which the said Troy and Greenfield Railroad Company then held or might any time thereafter have or obtain in the Southern Vermont Railroad Company." An additional mortgage of the Troy and Greenfield Railroad was made to the Commonwealth July 6, 1860, executed by D. N. Carpenter, H. Haupt

and E. G. Lampson, a committee duly authorized and appointed for that purpose, and also countersigned by Wendell T. Davis, treasurer. A third mortgage, dated April 5, 1862, signed by Alvah Crocker, president, was given by this corporation to the Commonwealth.

August 18, 1862, the directors of the Troy and Greenfield Railroad voted to instruct their president "to surrender to the Commonwealth of Massachusetts, under the several mortgages held by said Commonwealth, all the property of said corporation."

September 2, 1862, the stockholders of the Troy and Greenfield Railroad Company voted as follows:—

"That the corporation hereby ratify and confirm the vote of the directors, whereby they instructed the president to surrender to the Commonwealth of Massachusetts under the several mortgages held by said Commonwealth, all the property of the said corporation; and the president is hereby authorized and instructed to execute all instruments proper to perfect said surrender."

On the 4th day of September, 1862, "copies of these votes were served upon the commissioners," and on the same day they "took quiet and peaceable possession of the road and property in each of the towns in which it is situated."

At the same time the treasurer of the Commonwealth, for a default under the mortgages took a similar possession, of which a record has been made "in the counties in which the road and property is situated."

In accordance with the votes of the company its president executed a surrender of the property to the Commonwealth by an instrument, of which the following is a copy:—

Know all men by these Presents, That the Troy and Greenfield Railroad Company, a corporation duly established by law, doth, by these presents, surrender unto the Commonwealth of Massachusetts, under the several mortgages held by said Commonwealth, all the property of said corporation, real, personal or mixed, wherever situate, subject only to the right of redemption under the second section of chapter one hundred and fifty-six of the acts of 1862.

To have and to hold to the said Commonwealth and its assigns forever.

In witness whereof the said Troy and Greenfield Railroad Company, by Alvah Crocker, the president thereof, duly authorized and empowered by the votes of said corporation and the directors thereof, copies of which are hereto annexed, hath affixed the seal and subscribed the name of said corporation this thirteenth day of October, A. D. 1862.

TROY AND GREENFIELD RAILROAD COMPANY,

By ALVAH CROCKER. [SEAL.]

On the 23d day of December, 1862, Messrs. Haupt and Cartwright executed the following agreement:—

Know all men by these Presents, That we, Herman Haupt and Henry Cartwright, partners, under the name and style of H. Haupt and Co., hereby consent and agree to the possession that has been taken by the commissioners appointed according to the provisions of an Act providing for the more speedy completion of the Troy and Greenfield Railroad and Hoosac Tunnel, approved April 28, 1862, and by the Commonwealth of Massachusetts by said commissioners and the treasurer thereof, under the one hundred and fifty-sixth chapter of the Statutes of 1862.

And in consideration of all sums which the Commonwealth will be obliged to expend under the said Act, do hereby release all our right, title and interest in and to said railroad, and all the property of said company, in such manner, and to such extent, as to give to the Commonwealth priority of title, possession and use, over and above us or either of us, until after all debts and claims now existing, or which may hereafter arise in favor of said Commonwealth against said Troy and Greenfield Railroad, shall have been fully paid and satisfied; but nevertheless reserving all rights or claims which we, or either of us, may have against said Commonwealth for the injustice which by said Act has been done to us, or either of us, in consequence of which we expressly claim and reserve the right to petition any future legislature for redress of grievances.

Witness our hands and seals this twenty-third day of December in the year of our Lord, 1862.

H. HAUPT. [SEAL.]

HENRY CARTWRIGHT. [SEAL.]

*Witness:—*GEORGE L. TRULL to H. H., L. Y. WALKER.

The preceding conveyances, entries, votes and agreement, disclose the title under which the Commonwealth holds the railroad from Greenfield to the New York State line, subject to

the right of redemption provided in the second section of chapter 156 of the Acts of 1862, which right remains in the Troy and Greenfield Railroad Company for ten years after the road and tunnel are completed, and the same open for use.

The legislation of the State of Vermont favors the conclusion that the corporation of the Southern Vermont Railroad Company no longer exists for any practical purpose, as its powers and duties appear to be transferred to the Troy and Greenfield Railroad Company. Among the duties is that of annually making a report to the legislature of that State, on or before the third Thursday of October, of their proceedings, receipts and expenditures. Said last mentioned company is also required to appoint an agent on whom process may be served, who shall reside in Vermont, and whose appointment shall be recorded in the office of the clerk of the town of Pownal in Bennington County. For the performance of these duties and requirements it may be essential to maintain the organization of the Troy and Greenfield Railroad Company, which has had no meeting since August, 1865.

During the transactions detailed above, the Troy and Greenfield Railroad Company was struggling with obstacles which impeded the prosecution of its enterprise. Such subscribers to the stock as had been obtained, organized the corporation March 16, 1849, and an assessment of three per cent. was voted February 6, 1850. Stock to the amount of \$106,000 was apportioned among twenty towns in the vicinity of the line of road, and October 28, same year, a contract for construction was made with Gilmore and Carpenter, which the president of the company was authorized to execute. January 7, 1851, the directors voted to break ground upon the road. In 1855, a contract to construct the work was made with E. W. Serrell and accepted by the directors, and in 1856, February 7th, another contract for construction was made with Messrs. Serrell, Haupt & Co. Neither of these three contracts are found among the papers of the corporation.

July 28th, 1856, H. Haupt and W. A. Galbraith notified a dissolution of the firm of Serrell, Haupt and Co., and proposed to enter into a new contract for the work.

July 30, 1856, a contract was made with Herman Haupt, William A. Galbraith, C. B. Duncan and Henry Cartwright for

the construction of the road and tunnel. This contract was approved by the directors August 6, 1856, and under it H. Haupt & Co. performed the work upon the road and tunnel, until February 18th, 1858, except as the same was modified and changed by votes of the directors. On the last mentioned day, another agreement was made with Herman Haupt, Henry Cartwright, and such others as might be associated with them, who upon signing the contract were to be considered as parties to the same. This contract bears the signatures of D. N. Carpenter, President of the Troy and Greenfield Railroad Company and of H. Haupt & Co., by H. Haupt, and appears to be the last contract entered into for the completion of the road and tunnel, under the administration of the Troy and Greenfield Railroad Company.

July 23, 1858, a committee of the directors reported that 7,485 shares of the stock had been subscribed for unconditionally by persons solvent at the time of subscribing, 3,450 shares had been subscribed for conditionally, or by parties who were not solvent or whose subscriptions could not be collected. That upon 6,509 shares subscribed for unconditionally, twenty per cent. or more had been paid in cash; that 939 shares had been subscribed for by towns, and that the whole number subscribed, conditionally and unconditionally, was 10,545.

A record made at this meeting by order of the directors shows that twenty per cent. or more had been paid on 6,648 shares, and the amount paid on the same to be \$267,569. Against the name of H. Haupt & Co. was set the number of 5,000 shares. The work of constructing the road and tunnel was continued by H. Haupt & Co., under the last named contract, until July, 1861, when they ceased operations. The last advance by the State to the corporation on account of work performed under its administration, appears under the date of July 9, 1861, and the work is believed to have stopped on the 12th.

April 28th, 1862, the Legislature by law (chap. 156,) authorized the appointment of "three able, impartial and skilful commissioners, to investigate the subject of finishing the Troy and Greenfield Railroad, and of tunnelling the Hoosac Mountain; to report to the governor and council what, in their judgment, will be the most economical, practical and advanta-

geous method of completing said road and tunnel; the estimated cost of fitting the same for use; the time within which the tunnel can be completed, and what contracts can be effected, and with what parties, for completing said tunnel and road, and the probable cost of the same; the probable pecuniary value of the road and tunnel when completed; the sources and amount of traffic and income; and all other facts in their opinion useful to assist the governor and council in determining the best method of securing a continuous railroad communication between Troy and Greenfield.”

Under the authority of this Act, Messrs. John W. Brooks, S. M. Felton and Alexander Holmes were appointed commissioners, who, on the 28th day of February, 1863, made an able and comprehensive report, accompanied by the reports of Messrs. Storrow, (upon European tunnels,) and Latrobe and Laurie upon the Hoosac Tunnel. Their reports cover the whole ground of inquiry suggested by the law, and after an opportunity for their full consideration, the Act of April 29, 1863, (chapter 214,) was passed, authorizing the same commissioners, subject to the advice and approval of the governor and council, “to construct, complete and equip the Troy and Greenfield Railroad and Hoosac Tunnel.” This Act also approved and ratified the contracts for transportation executed by the Troy and Boston Railroad Company, February 18, 1863, by the Vermont and Massachusetts Railroad Company, executed February 20, 1863, and by the Fitchburg Railroad Company, on the 23d day of said February, which were contained in the said report of the commissioners.

Although the Act of 1862 authorized the immediate construction of the railroad from the eastern terminus of the same to the Hoosac Tunnel, and the continuance of the work upon the tunnel, by contract or otherwise, yet nothing was done upon either portion of the enterprise until after the legislation which followed the report of 1863. The undersigned find no record in the office at North Adams of the first steps taken in pursuance of the power conferred by the Act of 1863 upon the commissioners. But from the letter books it appears that on the 22d of August, 1863, Mr. Doane, who had been appointed chief engineer of the work, gave a receipt to the secretary of the Commonwealth for certain engineering instruments, and

on the 23d day of the following September, he addresses a letter to Mr. Haupt, making inquiries concerning applicants for employment. The first money entered on the books at North Adams for disbursement was \$15,000, in November, 1863. It was drawn from the treasury in September, 1863. The first vouchers on file in the office are for engineering, &c., for which there are receipts under date of July 31, September 8, and September 18, 1863. The first pay-roll for labor commences November 1, 1863, which is approved by the engineer December 18, and by the commissioners December 30, 1863. This labor was performed upon the "West approach."

On the resumption of the work by the commissioners, it was deemed essential to provide necessary supplies for the laborers, and to accomplish this end three trading stores were established, which were continued under the direction of Mr. O. P. Rice, who acted as paymaster till June 1, 1865, and thence under the management of Mr. P. M. Smith until September 1, 1867, when the Commonwealth ceased its connection with them, and sold the merchandise then on hand to Mr. Smith, who carried them on to the close of the work in October last.

The receipts from the stores while under the control of the Commonwealth were paid to the cashier or paymaster monthly, and the proceeds of the final sale of the merchandise also appear upon the books of the cashier.

The money paid direct from the treasury, after the appointment of the commissioners in 1862, for the investigations made by them and under their direction, and for various local services connected with the settlement of the accounts and debts of the contractors, and also the necessary examinations, reports, and other preparations, together with sundry payments for salaries, expenses, with grants to H. Haupt & Co., amounts to \$330,774.27, as appears by the treasurer's books.

The amount of money received at North Adams from November, 1863, the date of the first receipt, to December 31, 1868, both inclusive, is \$2,587,457 32

In addition to this, there has been paid to the cashier, as proceeds from the sales of merchandise, &c., as appears from entries numbered from 6 to 55 inclusive, 110,732 00

Making a total of receipts upon the cashier's books of \$2,698,189 32

There has been paid from the pay department
and cashier's office, from the commencement
of business to January 16, 1869, . . . \$2,683,585 25

Balance in the hands of cashier, Jan. 16, 1869, \$14,604 07

Vouchers for the above payments, and monthly statements of
the accounts, will be found in the auditor's office, the same
having been regularly transmitted by the cashier through the
Commissioners, to the governor and council.

Of this balance there were vouchers in the hands of cashier,
paid but not transmitted to the governor

and council, \$7,846 57

Cash in the Adams Bank, 6,458 36

Cash in office, including incidental expenses, 299 14

\$14,604 07

The books now show a loss on the store account
of \$361 71

To this sum should be added, for rent, horse
keeping, teaming, and material used to Dec.

1, 1866, 910 87

\$1,272 58

And the stores should be credited with sup-
plies on the work, school-room furniture,
and stamps for the pay-rolls, 932 22

Making a loss by the stores of \$340 36

Deducting from the disbursements made by the cashier the
amount paid for merchandise and material furnished the stores,
the remainder will show the amount sent to North Adams to be
expended on the tunnel, and for which the tunnel is properly
chargeable. This deduction has not been made. It may not
be difficult to separate the payment made on store account, but
to do so would involve a critical examination of all the vouchers
up to September 1, 1866. In the absence of such an examina-
tion, the books in the engineer's office furnish the best criterion
of the cost of the work, so far as it has been paid for by money
remitted to the cashier.

By the books kept in the engineer's office, the money
expended on the tunnel by payments at North Adams up to
January 1, 1869, was \$2,570,932.27.

In charging the vouchers paid by the cashier, the rents received and generally small sums of money for materials sold are deducted from the payments; and the same rule is observed in the engineer's office, so that when the books are settled the accounts will agree unless some loss of material has occurred.

Receipts and Expenditures on account of Tunnel, from November 1, 1867, to January 16, 1869.

Balance of Tunnel funds on hand, Nov. 1, 1867, . . .	\$7,044 45
Received November, 1867,	65,000 00
December, "	50,000 00
January, 1868,	55,000 00
February, "	40,000 00
March, "	40,000 00
April, "	40,000 00
May, "	50,000 00
June, "	34,927 32
July, "	85,000 00
August, "	50,000 00
September, "	67,530 00
November, "	20,000 00
December, "	35,000 00
Receipts from sales as shown in acc't No. 51, \$1,000 00	
" " " " " " No. 53, 658 12	
" " " " " " No. 55, 1,024 00	
	<hr/>
	2,682 12
	<hr/>
	\$642,183 89

Payments.

Account No. 50,	\$62,887 10
No. 51,	56,958 08
No. 52,	51,679 55
No. 53,	39,489 21
No. 54,	44,494 04
No. 55,	41,678 83
No. 56,	51,264 75
No. 57,	34,016 22
No. 58,	75,872 80
No. 59,	44,313 05
No. 60,	80,986 93
No. 61,	43,939 27
In the hands of Cashier,	14,604 07
	<hr/>
	\$642,183 89

Of this balance, there is in bank, January 6, 1869,	\$6,458 36
Vouchers paid,	7,846 57
Cash, including incidental expenses,	299 14
	<hr/> \$14,604 07

Statement of Receipts and Expenditures on account of the Hoosac Tunnel, from August, 1863, to January 16, 1869, as appears by the Books of the Cashier.

D A T E.	Receipts from the Treasury.	Amount received by sale of Supplies, not deducted on pay-roll, but shown on monthly accounts to Governor and Council.	Vouchers furnished Gov'r and Council. By Account No.—	Expenditures.
1863.				
November, . . .	\$15,000 00	No. 6, \$3,087 46	1 & 2,	\$10,160 59
December, . . .	25,000 00	7, 4,752 76	3,	27,163 08
			4,	22,119 25
1864.				
January, . . .	25,000 00	8, 2,398 09		
February, . . .	25,000 00	9, 4,952 61	5,	23,969 94
March, . . .	30,000 00	10, 3,884 64	6,	30,674 16
April, . . .	30,000 00	11, 3,897 70	7,	32,536 85
May, . . .	30,000 00	12, 5,315 99	8,	29,342 86
June, . . .	40,000 00	13, 4,223 34	9,	51,951 14
July, . . .	40,000 00	14, 4,558 18	10,	38,625 92
August, . . .	40,000 00	16, 7,080 20	11,	50,451 27
September, . . .	50,000 00	17, 1,611 67	12,	54,443 28
October, . . .	50,000 00	18, 2,223 69	13,	64,617 16
November, . . .	50,000 00	19, 1,399 46	14,	44,887 76
December, . . .	50,000 00	20, 1,810 34	15,	55,404 86
1865.				
January, . . .	50,000 00	21, 1,917 84	16,	51,861 82
February, . . .	50,000 00	22, 1,275 46	17,	50,430 92
March, . . .	40,000 00	23, 1,566 72	18,	41,292 73
April, . . .	30,000 00	24, 1,954 47	19,	30,315 18
May, . . .	35,000 00	25, 2,690 07	20,	31,469 63
June, . . .	30,000 00	26, 3,250 23	21,	30,685 25
July, . . .	30,000 00	27, 3,055 20	22,	34,863 56
August, . . .	40,000 00	28, 2,146 23	23,	44,107 87
September, . . .	50,000 00	29, 3,377 27	24,	50,308 84
October, . . .	50,000 00	30, 916 24	25,	46,732 21
November, . . .	50,000 00	31, 3,618 98	26,	57,943 35
December, . . .	50,000 00	32, 2,389 43	27,	50,982 14
1866.				
January, . . .	50,000 00	33, 2,741 64	28,	47,103 85
February, . . .	40,000 00	34, 1,000 33	29,	50,271 91
March, . . .	50,000 00	35, 4,118 71	30,	44,941 54
April, . . .	50,000 00	36, 2,316 82	31,	59,873 33

Statement of Receipts and Expenditures—Concluded.

DATE.	Receipts from the Treasury.	Amount received by sale of Supplies, not deducted on pay-roll, but shown on monthly accounts to Governor and Council.	Vouchers furnished Gov't and Council. By Account No. —	Expenditures.
May, . . .	\$50,000 00	No. 37, \$2,425 12	32,	\$50,499 67
June, . . .	50,000 00	38, 2,497 16	33,	48,670 24
July, . . .	40,000 00	39, 1,680 04	34,	48,884 18
August, . . .	60,000 00	46, 10,500 00	35,	63,774 89
September, . . .	50,000 00	48, 1,415 79	36,	51,859 58
October, . . .	50,000 00	51, 1,000 00	37,	41,710 00
November, . . .	50,000 00	53, 658 12	38,	68,244 42
December, . . .	50,000 00	55, 1,024 00	39,	50,279 87
1867.				
January, . . .	40,000 00		40,	33,665 92
February, . . .	30,000 00		41,	35,994 10
March, . . .	30,000 00		42,	31,441 75
April, . . .	30,000 00		43,	30,657 04
May, . . .	35,000 00		44,	29,384 71
June, . . .	25,000 00		45,	30,676 89
July, . . .	25,000 00		46,	32,027 25
August, . . .	25,000 00		47,	33,138 79
September, . . .	40,000 00		48,	32,828 17
October, . . .	80,000 00		49,	82,735 66
November, . . .	65,000 00		50,	62,887 10
December, . . .	50,000 00		51,	56,958 08
1868.				
January, . . .	55,000 00		52,	51,679 55
February, . . .	40,000 00		53,	39,489 21
March, . . .	40,000 00		54,	44,494 03
April, . . .	40,000 00		55,	41,678 83
May, . . .	50,000 00		56,	51,264 75
June, . . .	34,927 32		57,	34,016 22
July, . . .	85,000 00		58,	75,872 80
August, . . .	50,000 00		59,	44,313 05
September, . . .	67,530 00		60,	80,986 93
November, . . .	20,000 00		61,	43,939 27
December, . . .	35,000 00			—
Total, . . .	\$2,587,457 32	. . \$110,732 00	. .	\$2,683,585 25
Received from Treasurer, \$2,587,457.32; by sale of supplies, \$110,732.00; total,				2,698,189 32
Balance in hands of H. C. Cunningham, Cashier, Jan. 16, 1869,				\$14,604 07

RECAPITULATION.

Total amount drawn from Treasurer of State,	\$2,587,457 32
Sale of Supplies and Material, not deducted on Pay-Rolls,	110,732 00
	<hr/>
Total,	\$2,698,189 32
Vouchers have been furnished Commonwealth of Massachusetts to January 16, 1869, inclusive, amounting to	2,683,585 25
	<hr/>
Balance on hand, as per Account No. 61,	\$14,604 07

A Statement of the Annual Expenditures upon the Hoosac Tunnel, from the Re-opening of the Work in 1863, to January 1, 1869, as appears from the Books in the Engineer's Office.

HOOSAC TUNNEL.

[Mar.

	November 1, 1864.	November 1, 1865.	November 1, 1866.	November 1, 1867.	November 1, 1868.	January 1, 1869.
Deerfield Dam,	\$92,343 55	\$125,919 74	\$127,982 80	\$127,666 47	\$127,727 53	\$127,727 53
Race or Canal,	16,497 63	21,353 03	23,417 54	23,743 49	26,552 37	26,570 92
Excavation and Masonry, East End of Dam,	3,486 43	12,535 86	12,802 46	12,802 46	12,802 46	12,802 46
Wheel-pits and House,	4,707 81	45,878 09	70,723 23	73,023 49	80,420 97	81,219 17
Gates and Overflow,	837 28	9,419 73	9,986 26	9,986 26	10,026 56	10,026 56
Cost of Water-Power, East End Heading, .	-	32,425 88	103,731 45	203,117 86	238,933 31	238,964 43
East End Enlargement,	46,709 51	80,317 10	80,317 10	135,872 78	208,804 28	208,918 96
East End Heading Enlargement,	-	12,602 68	17,559 46	17,710 96	17,710 96	17,710 96
Central Shaft,	24,421 62	85,525 58	144,423 75	210,786 68	223,814 84	225,800 87
West Shaft,	26,100 39	75,778 60	179,041 69	298,113 89	419,746 50	421,031 53
West Approach,	83,684 31	134,794 62	247,900 75	420,962 36	522,857 89	538,614 12
Buildings at East End,	17,324 69	27,851 65	31,688 99	31,453 10	30,039 18	29,954 76
Buildings at West End and Shaft,	23,568 76	33,076 42	40,010 13	41,038 20	40,567 98	40,363 04
Buildings at Central Shaft,	1,939 44	9,620 43	12,026 83	13,980 54	19,106 38	19,044 73
Buildings, General Account,	-	7,694 39	9,537 37	9,686 56	9,536 56	9,499 06
Engineering and Superintendence,	31,429 46	59,999 90	84,840 48	97,307 47	107,511 66	109,840 95
Machinery, West Shaft,	8,620 48	36,388 62	57,111 73	75,021 34	112,924 56	117,331 33

Machinery, East End,	\$5,946 98	\$20,537 79	\$87,032 38	\$130,263 60	\$163,950 24	\$164,138 39
Machinery, Central Shaft,	6,626 16	22,472 93	51,364 01	59,137 89	65,311 65	75,895 66
Machinery, Deerfield Dam,	8,056 54	10,297 92	10,820 93	10,820 93	10,820 93	10,820 93
Machinery, West End,	—	36 62	539 89	576 84	576 84	576.84
Machinery, General Account,	2,049 66	18,927 68	62,600 76	63,971 53	63,971 53	63,971 53
Land and Land Damages,	10,576 92	8,613 84	17,513 21	19,595 25	20,470 93	20,077 54
Miscellaneous,	556 62	556 62	*	*	*	*
Totals,	\$415,483 24	\$892,625 72	\$1,482,973 20	\$2,086,640 13	\$2,534,186 16	\$2,570,932 27
Annual Expenses,	—	\$477,142 48	\$590,347 48	\$603,666 93	\$447,546 03	*

* Transferred to Troy and Greenfield Railroad.

OPERATIONS UPON THE TUNNEL.

The work of excavating the main tunnel closed September 24th, 1868, and the progress of the work was impeded during the year at the east end from want of water, the presence of anchor ice in the canal and flume, and the insufficiency of water and power during the repairs upon the flume and compressors. The general results of most of the work are, however, satisfactory.

The advance in the headings and adit since November 1, 1867, has been 2,082 lineal feet against 1,594 for the year ending at that date, and the number of cubic yards of excavation since November 1, 1867, has been 22,121, while for the year previous it reached only 14,410.

The progress at the east end for the year ending November 1, 1867, was $87\frac{1}{2}$ feet per month of working time. For the year ending November 1, 1868, it was 107 feet.

Measures were taken early in the year of 1868 for restoring the works destroyed by fire at the central shaft, and as early as the season permitted, the buildings were erected. But delays in the delivery and fitting up of the machinery postponed the completion of the works until September 15, when the hoisting of water commenced. Six bodies of the sufferers by the calamity of the preceding year, occurring through the unskillfulness of the contractors, were reached on the 14th of October, and the remaining seven on the 22d. All but one were recognizable, and they were severally and with due propriety interred in the cemetery at North Adams. After the removal of the bodies, the shaft was kept clear of water till the completion of the contract for the whole work, since when it has been allowed to fill. No excavation has been done at this point the present year, and the depth of the shaft remains as stated in the last report.

The work at the west shaft section, which extends west to the eastern limit of Mr. Farren's contract, has been much impeded in its westward advance by the flow of water. From November 1, 1867, to July 7, 1868, the progress in that direction was 290 feet. In two of the months—December and February—no advance was made, and in November but 5 feet. Well No. 4, located 680 feet west of the supplemental shaft, reached grade April 23d, and excavations were immediately

commenced east and west, in order to relieve the work of the water at the earliest possible time, and to dispense with the use of pumps. The west heading, which had the longest line of excavation, after traversing a distance of 308 feet met the adit driven by Mr. Farren October 27th, and thus opened a channel for the passage of the water from the tunnel east of west shaft to the west end, from whence it finds its way to the river. The pumps were discontinued, and this obstacle to the prosecution of the work has been overcome.

As appears from the engineer's report, the progress at the east heading of the west shaft, from November 1, 1867, to the close of the work, September 24, 1868, was 337 feet. The machine drills were not introduced until the latter part of June, and they encountered, during the months of July and August, very hard portions of the rock, making an average progress of $45\frac{1}{2}$ feet per month. In September the advance was equal to 61 feet per month. This result was obtained with six drills, being all that could be driven with the power available at that point. The carriages at this heading are constructed to carry five drills each, and with an adequate supply of power, ten drills may be expected to accomplish an average monthly advance of one hundred feet.

The advance in the tunnel heading and adit at this section of the work, is 1,280 feet against 543 feet for the year ending November 1, 1867, and the excavation for the same is 4,696 cubic yards against 2,349 for the preceding year. These figures suggest the necessity of an explanation:—

The advance of the east heading of the west shaft	
from December 1, 1867, to September 24, 1868,	
a period of $8\frac{5}{6}$ months, was	337 feet.
The advance of the same heading from June 14,	
1867, to January 1, 1868, $6\frac{1}{2}$ months, was .	289 “
The maximum progress of three months in 1868	
with machine drills, and for a portion of the	
time glycerine as an explosive, was. . . .	152 “
The maximum progress of three months in 1867	
with hand labor and powder, was	142 “

The rock removed in 1868 was more difficult of excavation than that encountered in 1867. By combining the progress

made in the tunnel heading with that made in the adits, the comparative advance made in 1868 over that achieved in 1867 is unduly magnified.

Well No. 4, as has been stated, reached grade

April 23d, 1868; since then two additional forces

have been engaged on the adits, who have ex-

cavated a distance of 403 feet.

And Mr. Farren has made an advance in the adits

since January 1, 1868, of 552 "

Making a total of adit excavated at these two points, 955 feet

During the summer, glycerine of a very good quality has been manufactured at this point under the direction of Dr. Mowbray, and has been used for several months in blasting in the tunnel east of the west shaft. No accident has attended its use. And while its effect in the heading did not meet the expectations of the Commissioners, the result of its operation in the bench below the heading justifies the belief that with due provision for its economic use, and essential care and attention bestowed upon its management, it will prove an effective agent in the prosecution of this enterprise.

The flow of water at this section has in some degree abated during the year. The commissioner acting superintendent for the year 1867, reported the pumps on hand and in use at this point at the close of the year as possessing the capacity of raising $1,987\frac{1}{2}$ gallons of water from the tunnel per minute, while the maximum influx was about 1,000 gallons. By the report of the resident engineer at the west end in February last, there was then in operation and ready to operate a pumping capacity of 1,900 gallons per minute, and a flow of water equal to 800 gallons. Acting under the direction of the governor and council, an additional pump of the capacity of 1,000 gallons per minute was ordered on the 19th of February last, as a reserve provision to meet any sudden increase of water that might be encountered in the progress of the work. This pump was delivered late in the season, and is now at the shaft. It has not, however, been set up, the pumps on hand proving amply sufficient to protect the miners and free the shaft from water.

PROFILE OF HOOSAC MOUNTAIN.

Hor. Scale 4000 feet to 1 inch.

Ver. " 1000 " " "

Length of Hoosac Tunnel when finished

Feb. 1st 1869 E. End heading. 5 282.0
 " " " " Enlargement 2 500.0
 " " " " Heading W. Shaft 4 056.0
 " " " " Brick Arch 931.0
 Total length opened

9,338.0
 15,693.0

Balance

Depth of Central Shaft when finished
 Feb. 1st 1869 down

1,030.0
 583.0
 447.0

Balance



DESCRIPTION AND CONDITION OF THE WORK.

The dam on the Deerfield River is about 20 feet high, composed of two parts; the apron and the dam proper. The aprons are three in number, rising in terraces as they extend up the river. The lower apron and the middle one are each about thirty-one feet long and the upper one is about sixty-eight feet. Upon the upper end of this apron stands the dam proper, covering about thirty-one feet of its surface, with its crest ten and one-half feet above the apron. The fall from the upper to the middle and from the middle to the lower apron is in each case four feet; the slope of the lower apron is one foot, and it has at its lower end a cement wall six feet deep, seventeen feet wide, which runs entirely across the river.

The crest of the dam is about two hundred and fifty feet long. The face of the upper apron is covered with hard wood timber, opposing an effectual resistance to the action of the ice which breaks to some extent the soft covering of the two below. In making the annual repairs upon these aprons it will be economical to use hard wood timber. The whole structure is now in good repair. The machine shop and wheel-house is one hundred feet long and thirty-six feet wide; twenty-eight feet of its length is of wood, the remainder is of stone. This building now contains four turbine wheels and four compressors; two wheels and two compressors having been added the present year. There is sufficient machinery and tools for performing all ordinary repairs required at this section, and the power is deemed ample to carry on the work during the season of a supply of water. For a few weeks in the summer and winter, and when the canal is encumbered with anchor ice, an engine of large capacity will be required to do the work allotted to the turbine wheels. A blacksmith shop is also located here. And the Commonwealth own beside, a store, school-house, three or four dwelling-houses, two offices and shanties sufficient for the accommodation of the laborers on the work.

The tunnel was originally designed to be throughout its length 26 feet wide by 26 feet high, and the work was prosecuted in that design until the appointment of Mr. Latrobe as consulting engineer in 1866, who recommended a reduction of the tunnel to 24 feet wide and 20 feet high, making provision for drainage below the base. This recommendation was adopted

for the rock tunnel and it is being worked to that measurement, but the dimensions of the brick arch have been retained as originally designed.

At the east end, the distance excavated is 5,282 feet and the tunnel is of full size from its portal to a point 810 feet west. For the remaining distance, which has been driven as a heading, less than one-third of the excavation has been made.

Central Shaft.

At this point the State has the buildings erected over the shaft, with a boiler-house, blacksmith shop, office, store, boarding-house, farm-houses and barns, saw-mill and shanties sufficient for the men hitherto employed at this section of the work, in addition to which is a farm containing about 250 acres, sundry lots of land and the hoisting machinery.

The shaft has been sunk to a depth of 583 feet and is within 447 feet of grade. The machinery at this point is in good condition. The hoisting engine and boilers are new. The former engine has been refitted, and the whole machinery and apparatus connected with it put in good repair. A large quantity of wood and other material is upon this locality, the most of which, with the saw-mill will be purchased by the contractors.

West Shaft and West Shaft workings.

A large amount of machinery has been located at this section, among which are nine boilers, four engines, nine pumps and one set of four air compressors; there are also buildings containing the motive-power, a machine and blacksmith shop, and shanties sufficient for the accommodation of the laborers. The brick-yard, glycerine works and two dwelling-houses are also within the limits of this section. The east heading of the west shaft is 4,056 feet from station O, at the west end. Of this distance 927 feet is a brick arch, 1,609 feet is a tunnel heading from the west shaft, and the remaining distance is perforated by a small heading, say seven by twelve feet, and an adit seven by four and one-half feet. A schedule of the buildings and machinery connected with the work and owned by the State, is in course of completion, and will be placed in the office at North Adams.

The west end of the tunnel as at present constructed is a

brick arch 927 feet in length commencing at station 4 and terminating at station 931. The first contract with Mr. B. N. Farren for its construction was made in May, 1866, and the work was commenced June 5th at station $31\frac{75}{100}$. Subsequently the arch was extended $27\frac{3}{4}$ feet west to station four. Its form is not an exact circle. The upper half of the arch is a semi-circle with a radius of 13 feet. The sides and invert are segments of a circle whose radius is 26 feet. Its height and diameter are each 26 feet.

The dimensions of the masonry are as follows :—

From station 4 to 140 there are six courses of bricks in the arch, and five in the sides and invert; from 140 to 231 there are eight courses of bricks all round. Up to this point the brick masonry is supported by a stone backing from two to three feet in thickness at the springing line of the arch. The backing is henceforward discontinued. From 231 to 242.5 the eight courses of bricks are continued; from 242.5 to 266 the arch and sides have eight courses and the invert but six; from 266 to 280 the arch and sides have eight courses and the invert but two, owing to a hard rock bottom. From 280 to 824 there are eight courses in the arch and sides and six in the invert, and from 883 to 931 the courses are reduced to seven in the arch and sides and the invert is discontinued, the bottom being of sufficient strength to support the masonry. At station 231 a slight modification of the structure was introduced by substituting a curve for the skewback formed by the meeting of the invert and sides. The form of the arch, which has been much commended, was designed by Mr. Thomas Doane, the first engineer under the Commissioners.

The difficulties attending the construction of the arch have been very great. A large portion of its length is quicksand; the earth at the top and sides of the excavation has required for the whole distance very strong support, and the water entering at all points added greatly to the other embarrassments. The progress was at times discouraging. In September, 1867, and January, 1868, only four feet of progress was made in each month, and in February, 1868, no advance was effected. The greatest difficulties were encountered between stations 528 and 705. A quartz or indurated rock vein of 42 feet thickness was found at station 540, and twelve feet in front of this the miners

struck a large flow of water which so much impeded their operations that six weeks were spent in reaching the vein. Two other considerable veins were met and in the vicinity of each large quantities of water were found. Immediately beyond the third vein which was five feet in thickness, the workmen struck mica and talc schist but not acted on by water, and from this point no great difficulty was encountered. Throughout the whole extent of the arch the masonry has been laid inside the timber supports, a large quantity of which has been used during the performance of the contract. At one point 2,000 feet was required to support one longitudinal foot of excavation. The engineer of the tunnel estimates that 500,000 feet of timber used in the supports has been buried during the progress of construction from inability to remove it. In the execution of the work it has been found necessary to excavate outside of the tunnel eleven hundred and sixty-six feet of extra heading at an expense to the contractor of \$10,263.12 being about nine dollars per running foot; the total length of adits both centre and sides being 2,344 feet.

The work of construction has been done under two contracts. The first for 457 feet, terminating at section 431, and the second for 500 feet, terminating at section 931. The Commonwealth furnished the cement for both contracts. The amount paid on the first contract was \$138,767.15, averaging \$324.51 per lineal foot, exclusive of cement. For the second, \$187,987.52. In the second contract the cost per lineal foot varied as follows: from 431 to 824, \$370.17; from 824 to 883, \$327.56; from 883 to 931, \$310.84. These prices are exclusive of cement, but they cover the expense of driving an adit to section 1,189, (258 feet,) at an expense of \$9 per foot. The cost of cement for the whole work was \$22,808.74, and deducting \$2,322, the expense of the advanced adit, leaves the cost of the brick arch \$372.44 per linear foot.

The quantity of bricks laid in the tunnel is 4,044,945.

Cost of laying the same per thousand, . . . \$85 32

Cost of laying the same per brick, . . . 8.532

These prices, of course, include the whole expense of excavation, timbering, drainage, bricks, etc.

The west end of the tunnel is not completed and the work is designed to be carried west with fifty additional feet of stone

arch and to be finished with a suitable granite façade containing about 800 yards of stone.

The work as it stands is a substantial and beautiful piece of masonry, reflecting great credit upon the contractor and upon the engineer and overseers in charge of the several departments of the work. Notwithstanding the insecurity of a large portion of the foundation, no settling of the structure is discoverable, nor has the lateral or vertical forces to which it is subjected, in the slightest degree varied its primary position or affected its symmetrical form. During the thirty-two months devoted to its construction, it has required the average service of about eighty men ; yet, notwithstanding the dangerous character of the undertaking, no casualty has occurred, and but one slight accident has happened to any one engaged. The intercourse between the Commissioners and the contractor has been uniformly pleasant, and no disturbance or disagreement between the employer and the employees has occurred during the continuance of their engagement.

THE TROY AND GREENFIELD RAILROAD.

The contract for the completion of the railroad east of the tunnel was made October 6th, 1866, and the work commenced on the line between Greenfield and Shelburne Falls on the 20th of the same month, and on the section above Shelburne Falls about April 1st, 1867. The road, as constructed, extends from its junction with the Vermont and Massachusetts Railroad to a point called Tunnel Station, which was assumed by chapter 202 of the Acts of 1860 to be within a half mile of the tunnel, but is about three thousand feet easterly thereof. The track was laid to this point about the last of July, 1868, and the cars of the Vermont and Massachusetts Railroad Company commenced running upon it the 15th of August following. The road was completed and accepted by the Commissioners on the 14th of October last, and is now operated by the Vermont and Massachusetts Railroad Company, under a lease dated October 8th, 1866, the provisions of which provide that the road is to be constructed from Greenfield to the Hoosac Tunnel. The rent reserved by the lease is twenty thousand dollars annually for the use of the road from Greenfield to Shelburne Falls, and ten thousand for its use from Shelburne Falls to the

tunnel, payable quarterly. The rent of the first section commenced January 1, 1868, and of the second section November 1, 1868.

The work upon the road has been faithfully performed. The materials of which it is composed are of the first quality, and in its construction and general character is entirely acceptable to the Commissioners, and creditable to the contractor and engineer in charge of the work. The coaches connecting with the western section at North Adams, pass over the mountain with safety and dispatch, and this road with its connections forms a safe and expeditious line of travel from the eastern portion of the State to the entire West.

In connection with the railroad there has been thrown across the Deerfield River, opposite the Tunnel Station, a truss bridge, thus preserving a communication at all times with the west bank of the river.

The amount expended upon the railroad from

October 20, 1866, to January 1, 1869, is . . . \$644,424 99

The payments as appear upon the cashier's books,
amount to \$641,894 99

To this should be added, paid
for station grounds in North
Adams,

2,530 00

 \$644,424 99

The report of the engineer of the
road shows the cost to be . . .

\$610,752 99

To which should be added, an
advance to Mr. Day on his
contract for bridge at the
tunnel,

3,672 00

 \$644,424 99

STATEMENT of the expense of completing the eastern section of the Troy and Greenfield Railroad by the Commissioners, from its junction with the Vermont and Massachusetts Railroad, near Greenfield, as appears from the Cashier's books:—

Receipts from the Treasury.

1866.	December,	.	.	.	.	.	.	\$25,000	00
1867.	January,	.	.	.	.	.	.	20,000	00
	February,	.	.	.	.	.	.	20,000	00

1867.	March,	.	.	.	.	.	.	\$25,000 00
	April,	.	.	.	.	.	.	20,000 00
	May,	.	.	.	.	.	.	20,000 00
	June,	.	.	.	.	.	.	25,000 00
	July,	.	.	.	.	.	.	40,000 00
	August,	.	.	.	.	.	.	25,000 00
	September,	.	.	.	.	.	.	35,000 00
	October,	.	.	.	.	.	.	40,000 00
	November,	.	.	.	.	.	.	35,000 00
	December,	.	.	.	.	.	.	50,000 00
1868.	January,	.	.	.	.	.	.	40,000 00
	February,	.	.	.	.	.	.	15,000 00
	March,	.	.	.	.	.	.	10,000 00
	April,	.	.	.	.	.	.	20,000 00
	May,	.	.	.	.	.	.	13,000 00
	June,	.	.	.	.	.	.	25,000 00
	July,	.	.	.	.	.	.	20,000 00
	August,	.	.	.	.	.	.	35,000 00
	September,	.	.	.	.	.	.	20,000 00
	November,	.	.	.	.	.	.	95,000 00
	December,	.	.	.	.	.	.	4,000 00
								<hr/>
								\$677,000 00

Returned to State Treasurer Feb. 7, 1869, by Hon.

J. M. Shute, 34,927 32

\$642,072 68*Expenditures.*

1867.	Account No. 1,	March 28,	.	\$83,602 27
	No. 2,	Aug. 27,	.	136,300 91
	No. 3,	Dec. 31,	.	151,393 05
1868.	Account No. 4,	Feb. 29,	.	13,776 45
	No. 5,	Feb. 29,	.	14,401 31
	No. 6,	March 31,	.	7,758 59
	No. 7,	April 30,	.	20,324 45
	No. 8,	May 30,	.	12,783 13
	No. 9,	Aug. 31,	.	76,077 05
	No. 10,	Nov. 11,	.	33,615 55
	No. 11,	Dec. 4,	.	85,619 49
1869.	Account No. 12,	Jan. 11,	.	6,242 74
Total expenditure to Jan. 11,				<hr/>
				641,894 99
Balance in hands of cashier,				<hr/>
				\$177 69

As before stated, the Act of 1860 recognized a station for the temporary limit of the railroad from Greenfield west, at a point within a half mile of the tunnel, and the survey of the route for present construction indicated a station about one-half mile from the place of crossing the river and about three thousand feet east from the eastern portal. This point has been treated as the western limit of the railroad while the tunnel was in the course of completion, and the contract with Mr. Farren for its construction extended only to this point. The lease of the Troy and Greenfield Railroad to the Vermont and Massachusetts Railroad Company and the Fitchburg Railroad Company, dated October 8th, 1866, contains a recital that the Troy and Greenfield Railroad is to be constructed from Greenfield to the "Hoosac Tunnel," and the lessees claimed before they accepted the same that the road should be constructed across the Deerfield River. To obviate this objection, the Commissioners agreed to extend the road with all convenient despatch to the west bank of the river, and upon that assurance the lessees agreed to accept the road.

To carry out this arrangement, the bridge has been put under contract with the approval of the governor and council, and agreements made for trestle work and grading to complete the road-bed to the bridge. The two last contracts have not been approved for the want of a sufficient appropriation to defray the cost of the same, while that relating to the bridge has to some extent been performed, and the work under it will, undoubtedly, be resumed in the spring.

The propriety of completing the railroad in accordance with the terms of the lease will be conceded, and the importance of immediately commencing the extension of the road will be appreciated when it is recollected that inattention to some small details touching the leasing of the extreme western section of this road and the leasing and purchase of the Southern Vermont Railroad has given rise to extravagant claims upon the Commonwealth which yet remain unadjusted.

The appropriation for 1868 was deemed sufficient to defray the cost of carrying the railroad to the west bank of the river. But the unexpected amount of extra charges on the lower section of the road and the course of the auditor, (for the first time adopted,) in charging one-half of the salaries to this appro-

priation, has caused a deficiency which it will be necessary to supply in order to complete the work.

The cost of extending the railroad to the east portal of the tunnel is estimated at sixty thousand dollars, of which about twenty-seven thousand dollars will be expended upon the bridge now in the course of construction. The trestle work is estimated at five thousand eight hundred and twenty-five dollars, the grading at twenty-one thousand one hundred and seventy-five dollars, and the track at six thousand and three hundred dollars. There is to the credit of the appropriation, as appears by the auditor's books, thirty-three thousand seven hundred ninety-six dollars and twenty-five cents. The deficiency of twenty-six thousand two hundred dollars and seventy-five cents may be supplied by an appropriation of the rents accruing from the railroad the current year, to the amount required.

The buildings upon the road are well adapted to its business. A temporary car-house will be required at the tunnel and a small station-house may be needed at Zoar. With these exceptions and that of the extension above named, the road in its construction and equipment conforms to the lease; and its permanent structures are well protected from the influences of the weather.

A plan and description of the railroad as located in Franklin County has been made and executed, and filed in the office of the clerk of the county.

One question upon this section of the road remains unadjusted. The station ground at Shelburne Falls has been enlarged by the addition of land upon the south side of the main track, obtained from Messrs. Lampson and Goodnow, and the engineer has agreed to convey to them in exchange a small strip of land north of the station-house. The Commissioners assented to this arrangement, as beneficial to both parties. It will be necessary to ask the legislature for authority to make the conveyance called for by the agreement; the execution of which should be dependent upon the conveyance by Lampson and Goodnow of the land described in their bond to the Commonwealth.

In connection with this portion of the railroad it is due to the officers of the Vermont and Massachusetts Railroad Company to say, that they have spared no pains or expense to enlarge the facilities of the railroad, or to accommodate the public travel upon it.

Continuation of the Road from the West End of the Tunnel to the extreme Western Section at North Adams.

This line has been three times surveyed. First, by Mr. Doane, who proposed to unite with the extreme west section at a point near the station-house at North Adams. In view of the adoption of this route on the 21st of November, 1866, a conditional bargain was made with Messrs. James Hunter & Son for a small piece of land as a part of the right of way. The second line was to some extent run by Mr. Manning, while chief engineer at the tunnel. This line did not materially vary from that run by Mr. Doane. They were both open to the objection of incurring very heavy land damages and of affording insufficient room for station ground. The third was surveyed under the direction of Mr. Crocker, while superintendent of the works. This line avoids the village of North Adams, saves a very large sum in land damages, and secures about twelve acres of land with the privilege of turning the course of the Hoosac River for a consideration of \$3,780, and will enable the Commonwealth to make any desirable arrangement for the mutual accommodation of the two railroad companies and the inhabitants of the village. A plan and location of this line has been made, executed and filed in the office of the clerk of Berkshire County. Of the above purchase money \$2,530 was paid June 13, 1868, which secures the title to the land without the privilege of changing the bed of the river. On the payment of \$1,250 the important advantage of changing the course of the river will be obtained and the value of the purchase largely increased.

The adoption of the last survey for the location of this part of the railroad intervening between the western section thereof and the west portal of the tunnel induced the abandonment of the contract with the Messrs. Hunter for the purchase of their land; and accordingly on the 12th of November, 1868, the Commissioners cancelled the contract and in conformity with its stipulations received from James Hunter and James E. Hunter two promissory notes payable to the Commonwealth for \$2,000 each, one in one year and the other in two years, with interest. The notes are deposited in the bank at North Adams for safe keeping.

The distance from the west portal of the tunnel to the present eastern terminus of the western section of the railroad is about two miles, and the estimated expense of constructing the road

over this space is \$110,000. Should the tunnel be extended west so that its façade might rest upon a solid foundation this expense would be materially lessened.

The title of the Commonwealth to the line of railroad west of North Adams, extending to the New York State line, has been already stated as derived under conveyances from the Troy and Greenfield Railroad Company, as follows, to wit: A conveyance in mortgage of its road, dated July 28th, 1855, and two subsequent mortgages of the same; also, a conveyance in mortgage of the Southern Vermont Railroad, dated April 21, 1860, being the same day on which the Troy and Greenfield Railroad Company acquired its title thereto. The contract of sale between the two corporations has been ratified and confirmed by the General Assembly of the State of Vermont, as herein before stated, and possession of both roads, under the mortgages, has been taken by authority of the laws of Massachusetts. Previous to the purchase of the Southern Vermont Railroad by the Troy and Greenfield Railroad Company, the corporation owning the former road had by a lease dated November 21, 1856, and which was probably executed January 8, 1857, conveyed its road with all the lands, depot-houses, water-tanks, or other structures belonging or that may hereafter belong to the party of the first part (the road to "be well and substantially built, and in conformity with the specifications in the contract between [said] Haupt & Co. and the Troy and Greenfield Railroad Company of Massachusetts") for a term co-extensive with the duration of its charter and any renewal of the same to the Troy and Boston Railroad Company, a corporation established in New York, and owning a railroad now running from the city of Troy to a point connecting with the location of the Southern Vermont Railroad.

It was stipulated in the lease that until the completion of the Hoosac Tunnel the following temporary structures would be permitted, viz.: timber abutments for bridges on each side of the Hoosac River, and a six degree curve to avoid the through cut at or near the eastern end of the road. The Commissioners are informed that the abutments actually constructed were of stone, and were received as permanent structures. The curve adopted is one of four and a half degrees only.

The lease also contains a provision that the Troy and Boston Railroad Company shall keep the road and fixtures in good

repair, at their own expense, during the continuance of the lease, except in case of casualty happening to "temporary structures." In such case, the temporary repair shall be borne by the Southern Vermont Railroad Company. The lease was not to bind the lessees "unless they obtained a lease of the Troy and Greenfield Railroad between North Adams and the Vermont line." The rent reserved in this lease upon its "completion and acceptance is twelve thousand dollars, payable as follows: At the Bank of Commerce, New York City, the interest coupons on [such] bonds as the Southern Vermont Railroad Company shall issue in payment for construction of said road, which sum shall not exceed one hundred and fifty thousand dollars, at an interest not exceeding six per cent. per annum, the principal payable in not less than twenty years from the first day of May next." The balance of the twelve thousand dollars, payable semi-annually, at the office of the Troy and Boston Railroad Company, in the city of Troy.

The Troy and Boston Railroad Company received a lease of that "portion of the Troy and Greenfield Railroad lying between the Pittsfield and North Adams Railroad depot and the line of the State of Vermont," dated on the same day, viz., November 21, 1856, to continue and be in force "until the completion of the Hoosac Tunnel."

The lease of the Troy and Greenfield Railroad contains the following clauses :—

"The said Troy and Greenfield Railroad Company does hereby agree to let and lease unto the said Troy and Boston Railroad Corporation said piece or part of said Troy and Greenfield Railroad, when finished, together with the lands, buildings, etc., belonging or that shall belong to said corporation at North Adams and along said line. The said railroad to be well and substantially built and finished at the same time with the Southern Vermont Railroad, and to be then delivered to the said party of the second part.

"And the said Troy and Boston Railroad Company, on their part, agree and bind themselves to pay for the use of said railroad as before herein described, the sum of eight thousand dollars per annum, during the time the same shall be held by the said corporation, and in that proportion for any lesser time. The same to be paid as follows: Four thousand dollars six months after the completion and delivery of the road and its acceptance, and the like sum semi-annually thereafter.

“The Troy and Greenfield Company to furnish or provide such freight and passenger-depot accommodations, turn-tables, wood-sheds and water-tanks and supply of water, as may be necessary for the convenient use of the road at Adams and other points, where necessary.”

After the execution of these leases, viz., November 2, in the year of our Lord 1858, at a meeting of the directors of the Troy and Greenfield Railroad Company, held at the American House in Greenfield, the following preamble and resolutions were adopted:—

Whereas, The towns of Williamstown and Adams have subscribed to the capital stock of the Troy and Greenfield Railroad Company the sum of ninety-three thousand dollars upon the condition that the payment shall be in town scrip maturing in thirty years, and that the scrip shall not be issued until the road is completed between Adams and Troy; that half the interest shall be paid by the Troy and Boston Railroad Company, and that a portion of the mortgage bonds of the Troy and Greenfield Railroad Company, in amount equal to the subscription of said towns, shall be deposited in the Adams Bank as security against the loss of the stock, from such a contingency as a sale of the road by the bondholders; therefore,

Voted, The subscription of the towns of Adams and Williamstown be accepted on the conditions above stated, and that the contract with the Troy and Boston Railroad Company be so altered, with the consent of that corporation, as to allow said company to pay one-half the interest on the scrip directly to the treasurer of the town, and deduct the same from the sum to be paid to the Troy and Greenfield Railroad Company under the lease—also that bonds to the amount of \$93,000, be prepared ready for delivery, and that Mr. H. Haupt and the treasurer be a committee to carry this vote into effect, as also any change of contract with said Troy and Boston Railroad Company, and attach the corporate seal of the company to any instrument or instruments of writing, which may be necessary to carry this vote into effect.

Voted, That the Trustees of the mortgage bonds of this corporation be and hereby are requested to deliver to Mr. H. Haupt and the treasurer ninety-three bonds of \$1,000 each, to be deposited by them in the Adams Bank, in compliance with the conditions and requirements of the votes of the towns of Adams and Williamstown in the subscription to the stock of the Troy and Greenfield Railroad Company—of these amounts sixty bonds are to be appropriated as

security for the town of Adams, and thirty-three bonds for the town of Williamstown.

W. T. DAVIS, *Clerk.*

Previous to the foregoing votes, to wit, on the 10th of July, 1857, the directors of the Troy and Greenfield Railroad Company had voted as follows: that "any subscriptions that may be collected, west of the Hoosac Mountain, shall be applied exclusively to the completion of that portion of the road," and that "the present subscriptions east of the Hoosac Mountain may be collected and applied to the payment of other liabilities of the corporation."

Influenced by these votes and by the facilities anticipated from the construction of the contemplated railroads, the town of Williamstown subscribed for thirty-three thousand dollars, and the town of Adams for sixty thousand dollars of the capital stock of the Troy and Greenfield Railroad Company upon the following conditions, which were severally required by the votes of their respective inhabitants:—

SUBSCRIPTION OF THE TOWN OF ADAMS.

Whereas, At a town meeting, held for that purpose on the fifth day of April, eighteen hundred and fifty-eight, the Town of Adams, Berkshire County, Massachusetts:—

Resolved, That the Town of Adams will subscribe to the capital stock of the Troy and Greenfield Railroad Company, to the extent of four hundred shares, in addition to the two hundred shares previously subscribed, on the following conditions, to wit:

1. No cash payments shall be required from this town, either for the former subscription or for the increase, but the payment for the whole shall be in town scrip, maturing in thirty years from the date of issue, the interest to be six per cent., and the coupons to be made payable annually at the Adams Bank.

2. No scrip shall be issued until the Troy and Boston Railroad Company shall execute a contract with the town, binding themselves until after the completion of the tunnel through the Hoosac Mountain, to pay one-half of the interest on the town scrip, which interest shall be paid into the Adams Bank in time to meet the payments on the coupons.

3. To protect the town against the possibility of loss of the stock from such a contingency as the sale of the Troy and Greenfield Railroad by the bondholders, the first mortgage bonds of the Troy and Greenfield Railroad Company to the extent of sixty thousand

dollars, shall be placed in the Adams Bank, under charge of a committee, to be appointed by the town, as hereinafter provided, to be held until the town shall be satisfied that such security is no longer necessary, and shall direct the committee by a vote of the town at a general or special meeting, to surrender them to H. Haupt & Co.

4. No scrip shall be issued until substantial heavy rails of not less than fifty pounds per yard, shall have been laid, and the road constructed in a manner suitable for the safe and convenient transportation of passengers and freight from the city of Troy to the village of North Adams, but when this condition shall have been complied with, and the certificates of stock issued, and placed with the bonds, in the hands of the committee, the whole of the scrip shall, without delay, be delivered to H. Haupt & Co.

5. A committee of three shall be chosen by ballot with power to subscribe for the stock, to issue the scrip, and to do and perform whatever may be requisite and necessary to carry this vote into effect. In voting for the committee the three persons having the highest number of votes shall be declared to be duly elected, and the person having the next highest number shall be authorized to supply any vacancy in the committee that may arise from death, resignation or otherwise.

6. When the committee shall have been elected as herein provided, and the subscription made upon the conditions herein named, the conditions annexed to the former subscription of two hundred shares, shall be considered as cancelled, and the committee heretofore appointed in relation to said former subscription, shall be released from any further duties or responsibilities in connection therewith.

Now, therefore, the said Town of Adams, which executes this agreement by George Millard, James Hunter, and Ezra D. Whitaker, a committee duly authorized for that purpose, and upon the fundamental conditions and stipulations embodied in Resolutions of said town, of which the foregoing is a true copy, and which are made a part of this agreement, does hereby subscribe for four hundred shares of the capital stock of the Troy and Greenfield Railroad Company, of one hundred dollars each share, in addition to the two hundred shares heretofore subscribed by said town.

TOWN OF ADAMS,

By GEO. MILLARD,

JAMES HUNTER,

E. D. WHITAKER,

Committee.

ADAMS, December 28th, 1858.

*Guarantee of the Troy and Boston Railroad Company to the
Town of Adams.*

Whereas, The Troy and Boston Railroad Company are the lessees from the Troy and Greenfield Railroad Company of that portion of the Troy and Greenfield Railroad Company's road which extends from the line of the State of Vermont to the Pittsfield and North Adams Depot in North Adams, together with certain lands, buildings and privileges in the lease of the same from the Troy and Greenfield Railroad Company more particularly mentioned, until the completion of the Hoosac Tunnel, now in progress of completion on said road last mentioned.

And whereas, The town of Adams, Berkshire County, in the Commonwealth of Massachusetts, has subscribed to the capital stock of the Troy and Greenfield Railroad Company to the extent of six hundred shares, of one hundred dollars each, on certain conditions, one of which is, that the Troy and Boston Railroad Company shall agree and bind themselves to pay one-half the interest on the town scrip which may be issued in payment of the subscription of six hundred shares aforesaid.

And whereas, The Troy and Greenfield Railroad Company have consented that the sum of eighteen hundred dollars parcel of the annual rent reserved in and by said lease may be paid as hereinafter provided.

Now know all men by these Presents, That in consideration of the premises, the said Troy and Boston Railroad Company, who execute the instrument by D. Thomas Vail, their president, do agree and bind themselves and their successors to the said town of Adams to pay or cause to be paid into the Adams Bank to the credit of the treasurer of the said town of Adams the sum of eighteen hundred dollars annually until the completion of the tunnel through the Hoosac Mountain, which payment shall be made at least ten days before the interest shall become due and payable on the town scrip aforesaid.

Witness the name and the corporate seal of the Troy and Boston Railroad Company, this seventh day of December, A. D. 1858. Affixed by D. Thomas Vail, its President.

TROY AND BOSTON RAILROAD COMPANY,
By D. THS. VAIL, *President*. [SEAL.]

Subscription of the Town of Williamstown.

[Extract from the Records.]

TOWN OF WILLIAMSTOWN, by their Committee duly authorized by vote of said town the ninth day of April, A. D. 1858, to subscribe three hundred and thirty shares to the capital stock of the Troy and Greenfield Railroad Company, on the following conditions, viz.:—

1. The payment for stock shall be in town scrip, maturing in thirty years from the date of issue, the interest to be six per cent. per annum, and the coupons to be made payable annually at the Adams Bank.

2. No scrip shall be issued until the Troy and Boston Railroad Company shall execute a contract with this town, binding themselves until after the completion of the Hoosac Tunnel, to pay one-half of the interest on the town scrip, which interest shall be paid into the Adams Bank in time to meet the payments on the coupons.

3. To protect the town against such a contingency as the loss of the stock from the sale of the Troy and Greenfield Railroad by the bondholders, the first mortgage bonds of the Troy and Greenfield Railroad Company, to the extent of thirty-three thousand dollars, shall be placed in the Adams Bank under charge of a committee to be appointed by the town, to be held until the town shall be satisfied that such security is no longer necessary, and shall direct the committee by a vote of the town at a general or special meeting, to surrender them to H. Haupt & Co.

4. No scrip shall be issued until substantial heavy rails, of not less than fifty pounds per yard, shall have been laid, and the road constructed in a manner suitable for the safe and convenient transportation of passengers and freight from the city of Troy to the village of North Adams; but when this condition shall have been complied with and the certificates of stock issued and placed with the bonds in the hands of the committee, the whole of the scrip shall, without delay, be delivered to H. Haupt & Co.

The question of the location of a depot shall be left open to be settled as the interests of the town and the accommodation of its citizens may require at a town meeting to be called for that purpose.

H. L. SABIN,

(330 shares.)

KEYES DANFORTH,

Three hundred and thirty shares.

BENJ. F. MILLS,

*Committee authorized by the Town of Williamstown to subscribe
to said Stock this 27th day of April, A. D. 1858.*

Certificate of J. WILDER, relative to the construction of the Troy and North Adams Railroad.

This may certify that I have been connected with the constructing and operating of railroads the past thirteen years, and the last seven years have had charge of the running of the Rutland and Washington, and part of that time the Albany Northern Railroad, commencing with their earliest operating. Also was familiar with opening of the Vermont Central, Rutland and Burlington, Ogdensburg, and Vermont and Canada Railroads, and that I have passed over the line of railroad from Troy to the village of North Adams, and made such examinations of the road and bridges between Hoosac Falls and the village of North Adams to satisfy me it is safe and convenient for the transportation of freight and passengers with the proper care usually bestowed in operating new roads, and that it compares very favorably with new roads when first opened for business that I have been acquainted with.

TROY, January 29, 1869.

J. WILDER.

A true copy. Attest:

JOHN B. WATERMAN, *Town Clerk.*

The Troy and Boston Railroad Company to the Town of Williamstown—Guarantee.

Whereas, The Troy and Boston Railroad Company are the lessees from the Troy and Greenfield Railroad Company of that portion of the Troy and Greenfield Railroad Company's road which extends from the line of the State of Vermont to the Pittsfield and North Adams depot in North Adams, together with certain lands, buildings and privileges, in the lease of the same from said Troy and Greenfield Railroad Company more particularly mentioned, until the completion of the Hoosac Tunnel, now in progress of completion on said road last mentioned. *And whereas*, the town of Williamstown, Berkshire County, in the Commonwealth of Massachusetts, has subscribed to the capital stock of the Troy and Greenfield Railroad Company to the extent of three hundred and thirty shares of one hundred dollars each, on certain conditions, one of which is, that the Troy and Boston Railroad Company shall agree to bind themselves to pay one-half the interest on the town scrip which may be issued in payment of the subscription of three hundred and thirty shares aforesaid. *And whereas*, the Troy and Greenfield Railroad Company have consented that the sum of nine hundred and ninety dollars, parcel of the annual rent received in and by said lease, may be paid as hereinafter provided.

Now know all men by these Presents, That in consideration of the premises, the said the Troy and Boston Railroad Company, who execute this instrument by D. Thomas Vail, their president, do agree and bind themselves and their successors to the said town of Williamstown to pay, or cause to be paid, into the Adams Bank, to the credit of the treasurer of said town of Williamstown, the sum of nine hundred and ninety dollars annually until the completion of the tunnel through the Hoosac Mountain, which payment shall be made at least ten days before the interest shall become due and payable on the town scrip aforesaid.

Witness the name and the corporate seal of the Troy and Boston Railroad Company this seventh day of December, A. D. 1858, affixed by D. Thomas Vail, its president.

TROY AND BOSTON RAILROAD COMPANY,
D. THOMAS VAIL, *President.* [L. S.]

Recorded this 3d day of February, A. D. 1859.

A true copy:

JOHN B. WATERMAN, *Town Clerk.*

Receipt of H. Haupt & Co.

Received, Williamstown, February 1st, 1859, of H. L. Sabin, Keyes Danforth and B. F. Mills, a committee authorized by a vote of the town of Williamstown, passed April 9th, 1858, to subscribe to the capital stock of the Troy and Greenfield Railroad Company to the extent of three hundred and thirty shares (330), the bonds of the town of Williamstown to the extent of thirty-three thousand dollars, which is in full payment of the subscription of said town.

The above bonds are numbered from No. 1 to No. 62 of \$500, and No. 63 to No. 82 of \$100 each, and dated January 1st, 1859, and making in thirty years, with annual interest at six per cent., and payable at the Adams Bank,

62 bonds	\$500 each is .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	\$31,000 00
20 "	\$100 " "	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	. . . . .	2,000 00
Total,								\$33,000 00

H. HAUPT & Co.

A true copy. Attest:

JOHN B. WATERMAN, *Town Clerk.*

I certify that the above is a true copy from the records of the Town of Williamstown.

Attest:

B. F. MATHER, JR., *Town Clerk of Williamstown.*

In addition to the foregoing guarantees of the Troy and Boston Railroad Company to the towns of Adams and Williamstown, that corporation has guaranteed to the town of Shelburne the payment of the interest of its subscription to the capital stock of the Troy and Greenfield Railroad until the completion of the tunnel. The amount of scrip issued on this subscription is \$6,000.

In accordance with these guarantees, and the vote of the directors of the Troy and Greenfield Railroad Company, the Troy and Boston Railroad Company have continued to pay to the town of Adams, as interest on its scrip annually, \$1,800, to Williamstown, \$990, and Shelburne, \$360, in all, \$3,150 annually, and the balance of the rent of the Troy and Greenfield Railroad, viz., \$4,850, was paid to Herman Haupt, from, say April, 1859, to September 1, 1862. The Troy and Boston Railroad Company has continued to pay the interest coupons specified in the lease of the Southern Vermont Railroad, and it paid the remainder of the rent to the treasurer of the Commonwealth until May, 1867, since when it has refused to make further payment, on the ground of having made repairs upon the Southern Vermont Railroad which the lessors of the road, or those claiming under them, were by the contract of lease obliged to make.

The Troy and Boston Railroad Company justify their refusal to pay the residue of rent reserved in the lease of the Troy and Greenfield Railroad, on the ground that the lessors have not (as is alleged) provided for such depot accommodations, turntables, water-tanks and water, as is stipulated for in the lease; and also they allege that they have been compelled to make repairs and erect new structures which it was the duty of the lessors to make.

In connection with this claim it is proper to state that the station ground at North Adams was originally very limited in extent. The depot building erected upon it was small, and has been destroyed by fire. About one acre and a half of additional land has been purchased, upon which has been erected a freight and passenger depot, engine-house and turn-table. The title to this property is held by one of the officers of the Troy and Boston Railroad Company. This whole property, including

four dwelling-houses, which are rented, cost about ten thousand dollars.

A claim to withhold the rent of the Southern Vermont Railroad was communicated to the Board in the spring of 1868, and at as early a day as possible a meeting was had with the directors of the Troy and Boston Railroad Company at North Adams, at which time a general examination of the road and structures took place.

Repeated efforts were made during the summer and autumn to procure a specification of the claim, with a view to its examination and consideration; but the claim for expenditures upon both roads was for the first time presented on the first day of December, at an interview with the president and treasurer of the Troy and Boston Railroad Company, in Boston. On the 3d of December, the Commissioners, in company with those officers, examined the localities and structures referred to in the specification of claim, with an intention of considering the same in connection with other facts bearing upon it. But the time of the Commissioners was so much engrossed in various matters involved in making a contract for the work, that it was impossible for them to devote any attention to this subject until after December 24th, since which time, having had no authority to confer with the directors of the Troy and Boston Railroad Company upon this question, they have delivered the specification of the claim, and the minutes of their examination, to the committee of the council having charge of the Troy and Greenfield Railroad and Hoosac Tunnel.

It is proper to add, that the bridges upon the western section of the Troy and Greenfield Railroad are uncovered, and consequently exposed to the injurious action of the climate. If suffered to remain in their present condition until the determination of the lease, they will then need rebuilding. In the adjustment of the claim made by the lessees, proper protection for these structures might be provided for; or failing a settlement, the State, as lessor, might, if deemed advisable, furnish the protection necessary for their preservation.

The Commissioners have endeavored to present such facts bearing upon the question pending between the parties to the leases of the western section of this railroad line as were accessible to them, in order to aid the governor and council in comprehending its merits and importance; and in this view,

the legislation of the State of Vermont, in connection with the Southern Vermont Railroad, and the conveyances and leases of both corporations, together with the papers bearing on the acceptance by the lessees of the Troy and Greenfield Railroad, accompany this Report.

The property comprised in this undertaking, and connected with it, consists of a railroad which has already cost upwards of \$1,500,000, and the entire machinery, fixtures and buildings, upon which, from time to time, have been expended \$700,000. In addition to this amount of property, there is to be added the extension of the eastern section of the railroad to a point near the east end of the tunnel, and the adaptation of the contemplated county road from the line of Vermont to the grade of the railroad at that point. The construction of the railroad from the west portal of the tunnel to the station ground at North Adams, and its connection with the western section now in operation, is also to be completed. The Commissioners respectfully suggest that, independent of the lesson which the history of this operation so forcibly teaches, the care of this large property, and the work yet to be performed by the Commonwealth to render the line of transportation available, requires efficient superintendence in order to protect the interests of the Commonwealth, and particularly to preserve all the property from deterioration, and a portion of it from unavoidable decay.

The following financial statement, embracing: (1.) The amount of scrip issued by the Commonwealth for the construction of the road and tunnel; (2.) The appropriations made therefor; (3.) Synopsis of the treasurer's account with the Commissioners from July 22, 1863, to December 31, 1868; (4.) The expenditure upon the whole work, and estimates touching its ultimate cost; (5.) Statement of the sinking fund; (6.) Income and property available to reduce cost of construction; may be found convenient for reference.

TROY AND GREENFIELD RAILROAD LOAN.

Amount of Scrip issued.

1858.	Amount issued,	.	£22,500 at \$4.44,	\$99,900 00
1859.	"	"	11,200	" 49,728 00
1860.	"	"	6,800	" 30,192 00

1860.	Amount issued,	. £55,800* at \$4.44,	\$247,752 00
1861.	“ “	. 18,200 “	80,808 00

£114,500

Add to this, difference between \$4.44 and \$4.84, 45,800 00

1868.	Amount issued, £610, at \$5.63 per pound, amounting to	. \$3,434,300 00
	of which carried to S. Fund,	. 481,900 00
	Balance to loan,	. . . . . 2,952,400 00

\$3,506,580 00

Scrip in Federal Money.

1860.	Amount issued to purchase Southern Vermont Railroad,	. . . . . \$200,000 00
1861.	Amount issued,	. . . . . 216,500 00
1863.	“ “	. . . . . 209,000 00
1864.	“ “	. . . . . 541,000 00
		<hr/> \$4,673,080 00

Appropriations for the Construction of Troy and Greenfield Railroad and Hoosac Tunnel.

1854.	By chapter 226 there was appropriated,	\$2,000,000 00
1860.	By chapter 202 the Troy and Greenfield Railroad was authorized to purchase the Southern Vermont Railroad, and there was appropriated therefor, for which scrip to the amount was issued,	. . . . . 200,000 00
1865.	By chapter 221 there was appropriated,	. 800,000 00
1866.	“ “ 293 “ “ “	. 900,000 00
1867.	“ “ “ “ “	. 600,000 00
1868.	“ “ 249 “ “ “ for tunnel,	. . . . . 5,000,000 00
1868.	By chapter 249 there was appropriated, for railroad,	. . . . . 250,000 00
1868.	By chapter 350 permission was given to use \$250,000 of the \$5,000,000 appropriation in advance of a contract.	<hr/> \$9,750,000 00

* In October and December.

Statement of the Treasurer's account with the Commissioners on the Troy and Greenfield Railroad and Hoosac Tunnel.

There is charged to the Commissioners on the treasurer's books, commencing July 22, 1863, when they entered in charge of the work, to December 26, 1868, \$3,595,231 59

Of this amount there was disbursed by the treasurer for unpaid labor and materials furnished by H. Haupt & Co., land damages, examinations of engineers and others, reports and salaries, together with \$75,814 voted by the legislature to Herman Haupt & Co., . . . 330,774 27

Which leaves a sum charged to the Commissioners for disbursement upon the work, of . \$3,264,457 32

From this deduct, as twice charged upon the treasurer's books, 34,927 32

Leaves a net charge for disbursement of . . \$3,229,530 00

On the cashier's books, kept at North Adams, the Commissioners are credited as follows:—

Money received for disbursements

on the tunnel, \$2,587,457 32

For disbursements on railroad, . . 642,072 68

————— \$3,229,530 00

Expenditures and Estimates upon the Railroad and Tunnel.

The governor, in his message to the legislature covering the report of the Commissioners, under date of March 12, 1863, (Senate Document No. 93,) says, that the total amount of advances made by the Commonwealth prior to the date of the suspension of work in the summer of 1861, was \$778,695 00

The amount disbursed by the treasurer from July 22 to December 31, 1868, is 330,774 27

The amount of money advanced to the Commissioners since the assumption of the work by the State to December 31, 1868, is as follows:—

For the tunnel,	\$2,587,457 32	
For the railroad,	642,072 68	
	<hr/>	\$3,229,530 00

\$4,338,999 27

To be paid under the contract with Messrs.

Walter and Francis Shanly, 4,594,268 00

\$8,933,267 27

Estimated amount of completing eastern section
of railroad to east portal of tunnel . . . 60,000 00

Estimated amount of completing western section
of railroad from west portal to North Adams, 110,000 00

\$9,103,267 27

From this sum should be deducted cash in the
hands of cashier at North Adams:—

On tunnel account, \$14,604 07

On railroad account, 177 69

14,781 76

Amount advanced and estimated for the comple-
tion of the work, \$9,088,486 51

This sum will be slightly increased by the necessary superin-
tending and engineering service during the execution of the
contract, and by the cost of transferring materials to the
contractors, &c.

The foregoing is the estimated cost of the work from the
assumed data, and does not include the contributions of the
several towns to the construction of the railroad, as follows,
to wit:—

From Adams,	\$60,000 00
Williamstown,	33,000 00
Buckland,	5,000 00
Shelburne,	6,000 00
Greenfield,	22,500 00

\$126,500 00

Of the sum of \$330,774 27
 paid at the treasurer's office, the chairman of
 the Commissioners in 1863 charged to the
 railroad, \$175,000 00

Following the rule adopted in the
 auditor's office the present year
 of charging one-half of the sal-
 aries to each division of the
 work, the road would be prop-
 erly chargeable with salaries,
 committee and legal expenses,
 &c., 27,036 21

And for a payment to Vermont
 and Massachusetts Railroad, 3,887 13

 205,923 34

Of the remaining sum, \$124,850 93
 \$22,814 is properly chargeable to the tunnel; \$53,000 was
 voted by the legislature to H. Haupt; \$49,036.93 the Commis-
 sioners from an inspection of the treasurer's books cannot
 distribute.

Sinking Fund.

The sinking fund of the Troy and Greenfield Railroad,
 January 1, 1869, was invested as follows:—

Bonds of the United States,	\$27,500 00
of Massachusetts,	35,500 00
of Maine,	25,000 00
of Connecticut,	40,000 00
of Rhode Island,	30,000 00
of New Hampshire,	17,000 00
County, city and town scrip,	396,043 00
Cash on hand,	12,083 71
	<hr/>
	\$583,126 71
Add for market value,	7,560 00
	<hr/>
	\$590,686 71

*Statement of Income and Property available to reduce the
ultimate cost of the work.*

Annual rent of the eastern section of the Troy and Greenfield Railroad, (payable semi- annually,)	\$30,000 00
Annual rent of the western sec- tion,	\$8,000 00
Deduct interest to towns,	3,159 00
	<hr/>
	4,841 00
Annual rent of the Southern Ver- mont Railroad,	\$12,000 00
Deduct 6 per cent. on \$150,000 in New York,	9,000 00
	<hr/>
	3,000 00
Two notes of James and James E. Hunter, \$2,000 each,	4,000 00
A saw-mill and personal property sold contractors,	47,682 15
Other personal property and several lots of land, say	10,000 00

The water power machine shop ; steam engines and machinery to be returned to the State on completion of the contract ; the office, shop and stable at North Adams ; all the buildings at west end, well No. 4, west shaft, central shaft and east end ; together with the rents of these last mentioned buildings during the construction of the work.

The agreement concluded on the 24th of December, 1868, with Messrs. Walter and Francis Shanly, gentlemen of great skill and experience in similar undertakings, has placed in their hands, at a remunerative price, and under a guaranty highly favorable to the Commonwealth, the further construction of the Tunnel and of the railroad through the same. The expectation may now be entertained that this important enterprise can be completed by the close of the year 1873, in a manner acceptable to the State and worthy the high character of the contractors.

ALVAH CROCKER.

TAPPAN WENTWORTH.

S. W. BOWERMAN.

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A P P E N D I X .

A P P E N D I X .

SUPERINTENDING ENGINEER'S REPORT.

ENGINEER'S OFFICE, NORTH ADAMS, MASS., }
December 24, 1868. }

*To the Commissioners of the Troy and Greenfield Railroad and
Hoosac Tunnel:*

In accordance with your request I have prepared the following Report of the progress and condition of the work upon the Hoosac Tunnel. Conforming to the method of previous engineering reports, I have made statistics of work for comparison to embrace the year as ending November 1st, 1868.

My own appointment and assuming charge under your direction of the work, occurred in May of the present year; consequently it has been necessary for me to refer to office records and other information as to all which transpired previous to that date. Statements relating thereto have been examined and collated with much care, and it is believed that all herein contained may be accepted with entire confidence.

It is proper here to make mention that the immediate administration was then transferred into my hands by the Hon. Alvah Crocker, Chairman of your Board, who had previously acted as superintendent; and it is also appropriate for me to recognize the success which had been attained in meeting obstacles which for some time threatened to suspend operations on one portion of the work. Some of the improvements which I have the satisfaction of reporting accomplished had been projected, or in part provided for by him, and the development of greater facilities and larger results has been since limited only by the means at command.

The anticipations expressed in the report of the year preceding, have been to a considerable extent realized in increased rates of advance and quantities of material removed. The total length of

heading and adit driven, and cubic contents of excavation removed from the tunnel, for the two years preceding November 1st, 1868, are as follows :—

	Linear feet Heading and Adit.	Cubic yards excavated from Tunnel.
Year ending Nov. 1, 1867, . . .	1,594	14,410
Nov. 1, 1868, . . .	2,082	22,121

A very much greater increase would have been accomplished but for the narrowness of the means made available by the Act of the last session. Previously to its passage, preparations had been made for very extended workings. A large force was already employed, with expectation of still further increasing it as the intended facilities and opportunities should be created. Instead of this, however, the force, during the months succeeding the passage of the Act, has been gradually curtailed, down to the time of discontinuing the headings, September 24th, in accordance with the necessity of the case. The following statement exhibits the total force employed upon the tunnel on the several dates therein specified :—

	June 1.	July 1.	August 1.	Sept. 1.	Sept. 24.
Number of employés, .	514	466	391	330	158

On the last mentioned date, work upon the headings was suspended in conformity with the order of the governor and council, dated September 22d. And thenceforward operations were confined to work done under existing contracts and to the preservation and protection of the works and property.

Statements of what has been accomplished on the several sections of the work are below submitted.

East End Section.

Amounts of progress during the present year and that preceding it are exhibited and compared in the following table :—

EAST END.	HEADING EXCAVATION.		ENLARGEMENT.			
	Linear feet.	Cubic yds.	SIDES AND ROOF.		BOTTOM AND CENTRAL DRAIN.	
			Linear feet.	Cubic yards.	Linear feet.	Cubic yds.
For year ending—						
Nov'r 1, 1867, .	1,051*	5,570	1,800	4,391	—	—
Nov'r 1, 1868, .	802†	5,736	2,210	8,697	2,256	2,504

* At rate of $87\frac{1}{2}$ feet per month of working time.

† At rate of 107 feet per month of working time.

The progress of heading for 1868, represents the result of operations continued at intervals, for seven and a half months only of working time, during a part of which a reduced force was employed. The linear advance has been (as above) 802 feet. The total length of full width heading is now 1,082 feet, terminating at a point 5,282 feet west of the east portal. The tunnel has been opened out to full size during the past year for a distance of 810 feet from east portal.

During nearly the whole of the month of January the working of the compressors was suspended, as the accumulation of anchor ice in the canal prevented the running of the turbine wheels, and before the end of May it became manifestly necessary again to suspend operations for the purpose of making thorough repairs and readjustment of the turbine wheels and compressing machinery then in use. At the same time the reconstruction of the flume, with addition of the waste-gates and iceway, was undertaken. This was prosecuted in a thorough and substantial manner, and early in August was already so far completed as to permit resumption of work in the heading. In addition to repairs of old machinery, the two new turbine wheels on hand, with a four-cylinder compressor for each, have been set up in complete working order during the present season; both of these compressors (designated as No. 3 and No. 4,) being intended to furnish air at the ordinary power pressure of fifty pounds for driving the pneumatic drills.

The apparatus for power, heretofore comprising only compressor No. 1, and the two small auxiliary machines, is thus increased to nearly threefold its former capacity, and the large addition thus provided, will enable future repairs to be made without delays to the advance of the heading, in addition to furnishing power for working machine-drills on the enlargement.

The waste-gates and iceway will obviate to a considerable degree the inconvenience heretofore caused by ice. The eighty-horse power steam-engine has not yet been put in service. The aproning of the dam, considerably damaged by the ice of the preceding winter, has been during the past summer thoroughly repaired.

In the driving of the heading the full width of twenty-four feet has been carried throughout, and continued experience confirms the opinion expressed in the consulting engineer's report of last year as to the propriety and economy of this method of working. The bottoming has been taken out and a central drain built and pipes laid therein for a distance of nearly half a mile, replacing the temporary expedients by which air was previously conducted to the heading.

The suggestion of extending machine drilling to the full section of the tunnel has been necessarily set aside thus far, but the provision of additional power not required at the heading is expected to lead to its early adoption.

The machines have been generally kept in good order and have done good service, but having been used two years are beginning to show wear. They will therefore be more costly in repairs henceforward, and are not equal, in point of performance, to those of Burleigh's later pattern.

In this connection it is proper to allude to a trial made in August last of Case's "Diamond Drill," built by the Windsor Manufacturing Company, of Windsor, Vt., which exhibited results so far favorable as to invite further comparison by an extended trial with those already in use. The problem of the *best drill* is of course always open to further investigation, and the improvements already made warrant hope of still further advancement hereafter.

Central Shaft Section.

The buildings over the central shaft, intended to replace those destroyed by fire October 19, 1867, were erected in the early spring; and on the 28th May I notified the Putnam Machine Company of our readiness to receive the new machinery which they had contracted to furnish. Meanwhile, the boiler-house had been built and new boilers set, and other accessory structures such as machine-shop, blacksmith-shop, &c., provided. Subsequently, while awaiting the arrival and setting up of the machinery, I enlarged the reservoir intended for supply of water to the boilers, the experience of the summer showing it to be of insufficient capacity for its intended service.

After considerable delays on the part of the contractors, the machinery was finally completed so far as to commence hoisting water September 15.

The work was greatly retarded by floating planks and timber obstructing the filling of the buckets, and continually requiring removal at all stages of descent as the water lowered.

On October 14, the first of the drowned bodies were recovered—six in number; and between that date and night of October 22, the remaining seven were found and taken up.

The following days exhibit the greatest progress in baling:—

Sept. 21, from 109 ft. to 154 ft., depth = 45 ft.; sunk in 20 hours working.

Oct. 13, from 499 ft. to 518 ft., depth = 19 ft.; sunk in 20 hours working.

The water gained in the intervals of baling, when near the top, about two feet in twenty-four hours; at or near the bottom the gain was six feet in twenty-four hours. Average influx, four feet. If baling had encountered no greater obstacles than during these days of greatest progress, the shaft would have been emptied in eighteen days, taking out beneath floor of offset 560 feet + $(18 \times 4 \text{ feet}) = 632$ feet depth of water. The area of the shaft in horizontal section is 318 square feet.

Comparatively few of the main beams of the shaft timbering were found to have been displaced; the planking, water-tanks, and all loose lumber left upon the different stagings constituted the main part of the floating debris by which the baling was obstructed.

West Shaft Section.

Embracing the supplementary shaft and workings from Well No. 4, and extending to the limit of Farren's contract. During the early part of the present year considerable delays were experienced from insufficient capacity or occasional derangement of the pumping apparatus. This is illustrated by the following table, showing progress of the heading westward from west shaft, which, through the favorable ground encountered, should have equalled an average rate of 80 to 100 feet monthly if uninterrupted by water:—

West Heading of West Shaft.

Progress made in month of November, 1867,	.	.	5	lineal feet.
“ “ of December, “	.	.	0	“
“ “ of January, 1868,	.	.	16	“
“ “ of February, “	.	.	0	“
“ “ of March, “	.	.	65	“

Progress made in month of April, 1868,	.	.	.	40 lineal feet.
“ “ of May, “	.	.	.	78 “
“ “ of June, “	.	.	.	67 “
During first seven days of July, “	.	.	.	19 “

Then meeting the heading run eastward from Well No. 4.

Well No. 4 reached grade on April 23, and headings in each direction were immediately commenced. At midnight of June 27, the westward heading having been extended a distance of 76 feet and then drawing an amount of about sixty gallons per minute, struck a spring estimated as flowing fifty gallons per minute. And the total discharge being shortly after increased by additional springs reached a maximum of 120 gallons per minute.

By way of provision for an increase of this character, I had caused to be placed in Well No. 4, during the month of June, the Worthington pump, to be used in place of the small plunger pump previously employed; and upon reaching the spring above referred to, an additional boiler being found requisite, was brought from east end and set up with all expedition, so that no very serious hindrance ensued. Considering, however, the reasonable probability that our workings westward would continue to encounter additional accessions of water, after conference with and approval by the commissioners, I ordered delivery of the new Knowles & Sibley pump, already completed by their order, to be in readiness for erection if needed.

Fortunately, however, it was not put in requisition. In the workings westward from Well No. 4, continued from the early part of July until the opening out to the west end, a distance of 232 feet, additional springs encountered came short of compensating the diminution of flow of those already passed.

The quantities of water pumped from the different shafts at the several dates below specified are estimated as follows:—

				Gallons per Minute.
January 15, 1868,	at West and Supplementary Shafts,			700
June 1,	“ West and Supplementary Shafts,	.	.	650
	and at Well No. 4,	.	.	50
				— 700
July 1,	“ West and Supplementary Shafts,	.	.	650
	and at Well No. 4,	.	.	110
				— 760

July 30, 1868,	West and Supplementary Shafts,	.	600	
	and at Well No. 4,	.	80	
			—	680
Oct. 28, “	West and Supplementary Shafts,	.	482	
	and at Well No. 4,	.	44	
			—	526

All the above estimates are based upon the actual movement of the pumps, with no allowance for leakage of valves. Careful gaugings of the stream through the west end, taken November 1st, showed an actual flow of about 420 gallons per minute, or about twenty per cent. less than as computed by rate of pumps. Some difference was to be anticipated, but not so great as this, and it is probable, since all the water lifted by pumps was discharged into the basin between Well No. 4 and west shaft, that a portion found its way back into the tunnel through subterranean passages.

The opening out to the west end accomplished in the latter part of October finally supersedes all necessity for pumping, as the water now escapes through the west portal by natural flow.

The advance of heading run eastward from west shaft has progressed continuously without any considerable hindrance from the cause which thus embarrassed the westward workings. It has, however, encountered rock of gradually increasing hardness. During the months of July and August it was especially difficult, offering great resistance to the drills; but in September assumed a character somewhat altered for the better. The following is a statement of monthly progress:—

		Length Driven.	Total Distance from W. Shaft.
In November, 1867,	.	33 feet.	1,272 feet.
December, “	.	22 “	1,294 “
January, 1868,	.	33 “	1,327 “
February, “	.	35 “	1,362 “
March, “	.	34 “	1,396 “
April, “	.	24 “	1,420 “
May, “	.	26 “	1,446 “
June, “	.	*21 “	1,467 “
July, “	.	47 “	1,514 “
August, “	.	44 “	1,558 “
September, “	.	†51 “	1,609 “

* Preparing for machine drilling.

† September 1st to 24th = 5-6 month. Rate, 61 feet per month.

But for the improved methods of working introduced, the advance would have been much less satisfactory than that we are enabled to exhibit above.

Concerning the employment of nitro-glycerine and machine drilling at west shaft, it is hardly necessary to remark that many difficulties are to be encountered in the training of men to a new service and in successfully employing a new description of fuse and explosive. Some remarks upon our experience in blasting with this compound will be found in a subsequent portion of this Report. Continuous use of machine drills was commenced at the west shaft in the latter part of June, and of nitro-glycerine as an explosive early in the month of August. Some delays were necessarily experienced at the first, but greatly improved progress was shortly attained. Some previous trials of machine-drilling had been made earlier in the present year, but without continuous progress, upon which satisfactory estimates of success might be based. The last workings made, including the month of September up to the time of suspension, about five-sixths of a working month, attained a linear progress of 51 feet with six drills only. The machinery provided at west shaft is only sufficient to supply the pneumatic power for the ordinary working of the above number, to which accordingly we have been necessarily confined.

The two drill carriages employed are larger than those at east end and are intended to carry five drills each,—in all ten drills working at the breast of the heading. Assuming, as we safely may, that the rate of progress is proportional to the number of drills employed, ten drills would advance 100 feet per month; and with full power provided and further experience to be acquired by the workmen, this and even greater average rates of monthly progress can be made and maintained.

These headings are run at top, i. e. above the excavations hereafter to be made, and of such height and top outline as to correspond with the roof of the completed tunnel. Amounts of progress upon this section of the work during present and preceding year are exhibited in the following comparative table:—

WEST SHAFT SECTION.	HEADING AND ADIT.		ENLARGEMENT.	
	Linear feet.	Cubic yards.	Linear feet.	Cubic yards.
Year ending—				
November 1, 1867, . .	543	2,349	161	2,100
November 1, 1868, . .	1,280	4,696	82	488

West End.

Farren's contract, embracing a distance of 931 feet, has been continuously prosecuted up to the date of this paper. Previous to November 1st, the adit making connection with the workings from the west shaft was completed, and a total length of 824 feet of brick arch was finished. His later advance has been over thirty feet per month, and it is expected that he will finish the remaining portions early in February.

All the great difficulties of the work, particularly described in preceding reports, are now passed. The advancing arch has for several months been extending into rock of gradually increasing compactness, until, about November 1st, a stratum was reached sufficiently solid to support the side walls of the arch and warrant dispensing with the invert. Further economy has been since effected by reduction of the thickness of the arch, corresponding with the diminished pressure of the more favorable material.

I append a table giving the comparative progress of the whole work for the three years ending November 1st, 1868:—

Comparative Progress of the Whole Work for Three Years ending November 1st, 1868.

YEAR.	EAST END.						CEN'L SHAFT.		WEST SHAFT.						SUPPLEMENTAL SHAFT.				WELL No. 4.		WEST END.		FINISH'D TUNNEL.		
	HEADING.		ENLARGE- MENT.		BOTTOM AND CENTRAL DRAIN.		Linear Pro-	Cubic Yds.	Linear Pro-	Cubic Yds.	EAST EN- LARGEMENT.		WEST HEAD- ING.		WEST EN- LARGEMENT.		Linear Pro-	Cubic Yds.	Linear Pro-	Cubic Yds.	Linear Pro-	Cubic Yds.		Linear Pro-	Cubic Yds.
											Linear Pro-	Cubic Yds.	Linear Pro-	Cubic Yds.	Linear Pro-	Cubic Yds.									
1866, .	592	2,443	167	417	-	-	153	1,993	637	2,358	578	1,444	18	106	294	721	200	579	75	139	131	-	131	Total East and West.	
1867, .	1,051	5,570	1,800	4,391	-	-	229	2,698	235	1,391	96	820	308	958	65	1,280	63	183	37	87	290	66	356		
1868, .	*802	5,733	2,210	8,697	2,256	2,504	-	-	370	2,587	82	361	910	2,109	-	127	-	-	75	175	834	-	1,144		

* Seven and a half months' work.

The limited employment of nitro-glycerine made previous to August 1st had been directed to excavations of enlargement, which very nearly resembles open cut work. The experience of the two months, August and September, is all we have that throws direct light upon its value in mining operations, using this phrase in its more limited sense, as applied to advance of headings only. The varying hardness and tenacity of rock, and other attendant conditions, make material variations in the progress of separate days or weeks, even in the same drift and with the same means and appliances of working.

For the reasons thus stated, actual records of advance without full knowledge and discussion of all attendant circumstances, and more especially when confined to short periods, must not be held conclusive in regard to the measure of advantage to be derived from its use. We cannot claim that in this short time full knowledge as to its best possible application has been obtained. Its superiority over the powder ordinarily used in blasting, as demonstrated by our own experience, may be briefly expressed in the following items:—

1. Less number of holes drilled in proportion to area of face carried forward. Estimated saving, 33 per cent.

2. Greater depth of holes permissible. Average depth for nitro-glycerine, 42 inches; for blasting powder, 30 inches.

3. More complete avail of the full depth of hole drilled. The greatly superior explosive power of the nitro-glycerine rarely fails to take out the rock to the full depth of the hole. Powder often comes short of this, and by reason of this loss of useful effect, a large percentage of additional drilling becomes requisite.

In all the foregoing comparison, I assume it to be understood that simultaneous blasting by electric battery is employed. The great economy of force secured thereby, whenever hard rock may be encountered, is admitted by all conversant with the matter, and since the early part of the summer I have continuously employed it in both the headings advancing into the mountain.

It is hoped and expected that farther experience will demonstrate an increase in each of the several items of advantage resulting from glycerine blasting; and it is only claimed that the best use was made of the short term of experiment afforded, and the most faithful and diligent effort was put forth to attain the best results and greatest benefit therefrom to the Commonwealth.

It was a source of great disappointment that Professor Mowbray should have been unable sooner to provide a continuous supply of the explosive, and in view of the fact that a small quantity was

furnished earlier in the year, it is appropriate to make mention of the obstacles which for a time delayed its further manufacture. The first lot produced was made with imported acids, reaching the actual standard of purity represented. In providing for more extended operations, acids were ordered from American works of the same *expressed* standard, but these, when received, were found so far below requirement, that a separate process of purification became necessary. For this process, retorts of a special pattern, not to be procured in market, had to be manufactured, and separate works erected, and in the several processes, necessity for which was not foreseen, much delay was unavoidably encountered. I have been fully satisfied throughout of Professor Mowbray's earnest desire fully to meet the expectations of the commissioners and of the public, and deem it proper to make this general statement of the more important circumstances, unanticipated, and therefore beyond his control, which disappointed his purpose.

The following statement exhibits in general terms the total results which have been attained in actual progress of the tunnel up to the present date.

At east end, the total distance penetrated is 5,282 feet, or two feet over one mile. Of the first half mile of this distance, a length of 810 feet is entirely completed, and the remaining length contains unfinished excavation only to an amount equalling the contents of less than 300 running feet of full size tunnel. In the succeeding half mile (driven as a heading,) the quantity removed constitutes about one-third the cubic contents of the tunnel. With exercise of proper judgment in working, all the material remaining to be removed within the limits above described can be taken out without obstructing the regular forward advance of headings and enlargements tending westward toward central shaft.

At the central shaft, depth already sunk, 583 feet. Remaining to reach grade, 447 feet. Additional buildings and machinery have been erected during the past year, more than sufficient for present purposes, and planned with judicious foresight for the future needs of the work. The present preparation is in many respects considerably superior to that destroyed or deranged by the fire which suspended operations.

It is believed that the shaft can be sunk to the additional depth required, without extraordinary effort, within the time prescribed by the contract, and its workings will then commence to perform the important part which they are expected to bear in expediting the completion of the tunnel.

At west shaft and west end workings, a total continuous distance of 4,056 feet has been opened, exceeding three-fourths of a mile. Of this distance, 821 feet had been excavated and lined with brick arching up to November 1st; and of the remainder, a quantity equal to about one-fourth of full size excavation had already been removed.

The whole length of the tunnel, exclusive of accessory structures required at west end, is 25,031 feet, or four and three-quarters miles very nearly, from which, deducting one and three-quarters miles already penetrated, we have somewhat less than three miles of rock yet to be bored, and this is to be practically divided by the central shaft into two tunnels, each of about one and a half miles length.

Below is given a statement of cost of the whole work done under the commissioners up to January 1st, 1869.

Statement of the amounts expended upon all work done on the Hoosac Tunnel under direction of the Commissioners up to January 1, 1869.

Deerfield Dam,	\$127,727 53
Race,	26,570 92
Excavation and masonry at east end of dam,	12,802 46
Wheel pits,	81,219 17
Gates and overflow,	10,026 56
East end heading,	238,964 43
" enlargement,	208,918 96
" heading enlargement,	17,710 96
Central shaft,	225,800 87
West shaft,	421,031 53
West approach,	538,644 12
Buildings, east end,	29,954 76
" west end and shaft,	40,363 04
" central shaft,	19,044 73
" general account,	9,499 06
Engineering and superintendence,	109,840 95
Machinery, east end,	164,138 39
" Deerfield dam,	10,820 93
" central shaft,	75,895 66
" west shaft,	117,331 33
" west end,	576 84
" general account,	63,971 53
Land and land damages,	20,097 54

Total expended up to January 1, 1869, . . . \$2,570,932 27

In transferring the work from the direct and immediate administration of the State into the hands of contractors, as is the effect of the instrument this day executed, it is satisfactory to look back upon difficulties met and overcome, and to remark how, out of the exigencies and experiences of this enterprise, new measures of skill have been called out, and new resources developed, which must avail greatly for the benefit of all similar undertakings hereafter.

The history of the great European counterpart of this work corresponds closely with our own record: greater skill attained, and better devices and methods, give continually increasing progress and diminishing cost.

All the improvements made have directly inured to the benefit of the Commonwealth, and in many of the late proposals for the work the intelligent judgment of experienced bidders accepted conclusions as to time and cost which were then only inferentially proved, and did not till a later period attain their actual fulfilment.

The future cost of the work to the Commonwealth being now definitely established, the advantage of such future improvements as may be attained will be willingly conceded to the contractors as the rightful reward of their energy and skill.

In conclusion, I wish to render my thanks to those employed with me in this work, from whom I have received valuable assistance. Where so many have given faithful service and evinced a generous ambition to be useful, it is pleasant to express the feelings of approval and esteem which they have well deserved.

BENJ'N D. FROST,
Superintending Engineer.

REPORT OF THE CHIEF ENGINEER.

To the Commissioners of the Troy and Greenfield Railroad and Hoosac Tunnel, ALVAH CROCKER, TAPPAN WENTWORTH, and SAMUEL W. BOWERMAN, is respectfully submitted my Report on the construction of the Troy and Greenfield Railroad for the year 1868.

At the date of my last Report, the railroad was completed, (or nearly so) as far as Shelburne Falls, and in operation, by the Vermont and Massachusetts Railroad Company.

About the last of July the track was laid to the Tunnel Station, but was not in order for traffic until August 15th, at which time the Vermont and Massachusetts Railroad Company commenced running one train a day, each way, over the road.

To finish the ballasting, widen the embankments, and protect the slopes with the necessary rip-rap, required the constant use of a construction train until the acceptance of the road by the commissioners, October 14th.

Since that time the road has been controlled and operated by the lessees, although the completion of some of the buildings was necessarily delayed until a later date.

In my last report I gave somewhat in detail, the alignment and gradients of the road from Greenfield to the Tunnel. I now propose to give a statement of the buildings erected—the cost of the same, and the cost of the construction of the railroad.

Buildings.

At Greenfield, Shelburne Falls, Charlemont, and at the tunnel, water rights have been purchased, reservoirs built, aqueducts laid,—and at the three stations last named, water tanks of sufficient capacity erected. The supply of water is considered ample for present and future use.

At Greenfield, the structures are: a water station, turn-table, and tool-house. At no distant day other station buildings will be required here.

At West Deerfield, a flag station.

At Bardwell's Ferry, a dwelling-house and depot combined.

At Shelburne Falls, a passenger-house, freight-house, engine-house, woodshed, turn-table, water-station and tool-house.

At Buckland, a flag station.

At Charlemont, a passenger and freight house combined, a water station, woodshed and tool-house.

At Zoar, one building for freight and passengers.

At the tunnel, a passenger and freight house combined, an engine-house, woodshed, water station, turn-table and tool-house.

Also at the last place, a bridge over Deerfield River, and a highway from the same to the depot. A car-house is much needed at this station, but it cannot well be built before another spring.

Cost of Buildings and Fixtures.

At Greenfield,	\$3,595 30
West Deerfield,	223 13
Bardwell's Ferry,	2,184 90
Shelburne Falls,	11,804 32
Buckland,	233 50
Charlemont,	4,726 54
the tunnel,	10,194 39
Highway bridge and road,	5,333 50
<hr/>	
Total amount,	\$38,295 58

Cost of Railroad.

Paid to B. N. Farren, under his contracts,	\$560,576 00
“ “ for extra work,	4,886 38
for railroad iron, chairs, spikes, ties, straighten-	
ing old rails, laying track, &c., for guard rails	
and extra sidings,	8,978 80
for protecting banks of Green River,	838 13
<hr/>	
Total amount,	\$575,279 31

Engineering expenses, including office rents, inspectors' bills, records, &c., \$20,926 00

Land damages, including depot grounds at the various stations, and \$2,530 paid for depot grounds at North Adams, \$6,252 10

Summary.

For graduation, masonry, bridging, fencing and super-structure,	\$575,279 31
Buildings and fixtures,	38,295 58
Engineering and agencies,	20,926 00
Land damages and station grounds,	6,252 10
Total expenditures since August, 1860, exclusive of _____	
tunnel bridge,	\$640,752 99

Length of railroad, 29½ miles.

The alteration of highways and railroad crossings have been completed, and the same accepted by the county commissioners.

I have made a new plan and description of the location of the railroad in Franklin County, conforming to the line as actually constructed, embracing all the lands owned by the Commonwealth, and the same has been filed in the county clerk's office.

A new location has also been made between the west portal of the Hoosac Tunnel and the village of North Adams, and a plan and description of the same filed in the Berkshire County clerk's office.

I have also a book of plans, in which are the plans of land taken from each landholder on the line of the railroad, with the description of each, as copied from the several conveyances given, noting therein the reservations of cattle-passes, crossings, &c., &c., as mentioned in each deed and writing.

Also a profile of the line from Greenfield to the tunnel, with the several gradients indicated thereon, according to actual construction, and showing the location and size of all culverts, bridges, drains, &c., &c.

Contracts have been made for a double track railroad bridge, to span the Deerfield River near the east portal of the Hoosac Tunnel. One pier for the bridge is nearly completed, and the foundation courses laid for the second. The whole structure completed will cost about (\$27,000) twenty-seven thousand dollars.

The contracts require the work to be finished, ready for the track, by July 1st, 1869.

ALFRED R. FIELD,

Chief Engineer Troy and Greenfield Railroad.

GREENFIELD, December 22, 1868.

Lease of the Eastern Section of the Troy and Greenfield Railroad to the Fitchburg and Vermont and Massachusetts Railroad Companies.

THIS AGREEMENT, made and entered into this eighth day of October, in the year eighteen hundred and sixty-six, by and between the Commonwealth of Massachusetts, by James M. Shute and Alvah Crocker, commissioners appointed according to the provisions of an act providing for the more speedy completion of the Troy and Greenfield Railroad and Hoosac Tunnel, approved April 28th, 1862, being chapter 156 of the acts of that year, party of the first part, and the Fitchburg Railroad Company and the Vermont and Massachusetts Railroad Company, party of the second part, witnesseth that

Whereas the said party of the first part is about to proceed with the construction of the Troy and Greenfield Railroad from Greenfield to the Hoosac Tunnel,

Now, therefore, the said party of the first part agrees to let and lease unto said party of the second part said railroad when finished, together with the depot and other buildings, and turn-tables, to be constructed upon the line thereof, as hereinafter stipulated.

And the said party of the first part agrees to build said railroad in a substantial manner, corresponding with the average of well-built railroads in New England, and to put it in complete condition to operate, furnishing therefor the necessary depot and other buildings along the line, and also suitable turn-tables at Greenfield, Shelburne Falls, and the Tunnel, and building suitable side tracks, not exceeding one mile in length, in all.

And the said party of the second part agree and bind themselves to pay for the use of the said railroad, from and after the time when the same shall have been completed as far as Shelburne Falls, the sum of twenty thousand dollars annually, and from and after the time when the said railroad shall have been completed from Shelburne Falls to the Tunnel, the further sum of ten thousand dollars annually.

And the said party of the second part agree, that when the said railroad shall have been completed as far as Shelburne Falls, they will thereafter keep said railroad in good repair as far as Shelburne Falls, ordinary wear and tear, and all subsidence and damages arising from the defective and insufficient construction of the road excepted, which shall be repaired by the Commonwealth; and when said railroad shall have been completed as far as the Tunnel, they will keep the whole of said railroad, from Greenfield to the Tunnel, in good repair, with like exceptions.

It is agreed that freight shall be carried over said railroad for the Commonwealth at prices not exceeding those usually charged for like freight, transported for like distances, on the Fitchburg and Vermont and Massachusetts Railroads.

It is understood and agreed that the Commonwealth will proceed with all reasonable and practicable dispatch in constructing the Hoosac Tunnel, and that in case of the suspension of work thereon, brought about by action of the legislature, or other competent authority, this agreement may then be vacated at the option of either party thereto, upon written notice given by either party thereto to the other; but any amounts due under the same for rent at the time when such notice may be given, shall remain due and payable, notwithstanding that this agreement has been vacated; otherwise this agreement shall continue in force until the completion of the Hoosac Tunnel.

The rent stipulated for herein shall be payable by the party of the second part to the party of the first part, quarterly, on the first days of January, April, July and October in each year, and upon the termination of the agreement proportionately from the last quarter day.

In testimony whereof, the said Commonwealth, by the said commissioners, and the said Fitchburg and Vermont and Massachusetts Railroad Companies, by their respective committees hereto duly authorized, have executed these presents, and the said commissioners have hereunto set their seals, and the said companies have caused their corporate seals to be hereunto affixed, the day and year first above written.

(Signed,)

VERMONT AND MASSACHUSETTS R. R. CO.,

By their Committee, DANIEL S. ROBINSON, *Pres't*,

OTIS T. RUGGLES, *Sup't*.

FITCHBURG RAILROAD COMPANY,

By their Committee, WM. B. STEARNS, *Pres't*,

J. B. BRIGHAM,

M. J. WITT.

Witness to the signature of the Committee of the Vermont and Massachusetts and Fitchburg Railroads.

M. D. BENSON.

JAMES M. SHUTE,

ALVAH CROCKER,

Commissioners.

BOSTON, October 12, 1866.—The foregoing lease is approved in Council this day.

Attest:

OLIVER WARNER, *Secretary.*

The form of the foregoing contract is approved.

AUSTIN J. REED, *Attorney General.*

Letters showing the Subscriptions of certain Towns to the capital stock of the Troy and Greenfield Railroad.

SHELBURNE FALLS, Feb. 11, 1869.

HON. TAPPAN WENTWORTH:

Dear Sir:—Shelburne passed a resolution June 8th, A. D. 1865, to subscribe \$12,000 to the capital stock of Troy and Greenfield Railroad.

The amount for which she issued her bonds, and the interest of which we receive from Troy and Boston Railroad Company and pay over annually, is \$6,000.

So it seems she did not finally take the whole amount.

Very truly yours,

A. K. HANKS,
Town Clerk of Shelburne.

BUCKLAND, Feb. 14, 1869.

HON. T. WENTWORTH:

Dear Sir:—In reply to yours of the 9th inst, which was received last night, I have to say, that the town of Buckland subscribed for 50 shares and paid \$5,000 in town scrip, on which it is now paying 6 per cent. interest annually.

Whether the scrip was delivered to the railroad company or the contractor, I am unable to say.

Respectfully yours,

R. L. PACKARD,
Treasurer of Buckland.

GREENFIELD, Feb. 10, 1869.

HON. TAPPAN WENTWORTH, *Commissioner, &c.:*

Dear Sir:—Your note of the 9th inst. was duly received, and in reply I would state, that at a town meeting held July 6, 1859, "it was voted that the town will subscribe to the capital stock of the Troy and Greenfield Railroad Company to the extent of three hundred shares of one hundred dollars each," &c., upon certain conditions. And on the 6th day of July, 1859, the committee appointed

therefor issued the scrip of the town to the railroad company, to wit: 15 bonds of \$500 each, each dated Jan. 1, 1860, amounting to the sum of \$7,500, at 6 per cent. per annum, payable January 1st of each year, (coupons annexed.) And on the 3d day of January, 1861, the town issued to said railroad company 30 bonds of \$500 each, at 6 per cent. per annum, amounting to \$15,000, making in the whole issued to said railroad company the sum of \$22,500. The remaining \$7,500 voted by the town was never issued. The bonds run 30 years from date, and all have coupons annexed.

Respectfully yours, &c.,

N. S. WELLS.

Town Clerk and Treasurer.

OFFICE OF THE TROY AND BOSTON RAILROAD Co., }
TROY, N. Y., February 17, 1869. }

HON. TAPPAN WENTWORTH:

Dear Sir:—Yours of 15th is at hand. We pay Adams interest on scrip \$1,800, Williamstown \$990, Shelburne \$360, in all \$3,150; this is all we pay towns. We think we gave Haupt & Co. contracts to pay other towns, but as books and papers were all burned in 1862 we cannot tell to whom. None others have demanded payment, so we think he did not deliver any more. I cannot tell when we commenced paying Haupt & Co., but believe we commenced in 1859, or Jan. 1, 1860, and paid him up to Sept. 1, 1862, since which we have not paid anything on Troy and Greenfield, except to the three towns, \$3,150 per annum. We have to-day forwarded to the governor our account, which shows everything. I think it would be well for you, where towns have issued scrip, to inquire if they hold any covenant of ours.

Very truly yours,

DAN ROBINSON,

Treasurer.

*Troy and Greenfield Lease to Troy and Boston Railroad
Company.*

These Articles of Agreement, made this 21st day of November, A. D. 1856, by and between the Troy and Greenfield Railroad Company of Massachusetts, of the one part, and the Troy and Boston Railroad Company of the State of New York, party of the second part:

Whereas, the said Troy and Greenfield Railroad Company have contracted with H. Haupt & Co. for the building of their railroad from Greenfield to the State line, at or near Williamstown, including the Hoosac Tunnel; and whereas, that portion of said road lying between the Pittsfield and North Adams Railroad depot, in North Adams village, and the State line of Vermont, is expected to be shortly finished, and it is desirable that the same shall be brought into use; now, therefore, these presents witness, that the said Troy and Greenfield Railroad Company does hereby agree to let and lease unto said Troy and Boston Railroad Corporation said piece or part of said Troy and Greenfield Railroad when finished, together with the lands, buildings, etc., belonging, or that shall belong, to said corporation at North Adams, and along said line to the Vermont line near Williamstown, said lease to continue until the completion of the Hoosac Tunnel, and no longer, and then the road and fixtures to be restored to said party of the first part, in good repair and condition.

The said railroad to be well and substantially built, and finished at the same time with the Southern Vermont Railroad, and to be then delivered to said party of the second part.

And the said Troy and Boston Railroad Company on their part agree and bind themselves to pay for the use of said railroad, as before herein described, the sum of eight thousand dollars per annum, during the time the same shall be held by the said corporation, and in that proportion for any lesser time. The same to be paid as follows: Four thousand dollars six months after the completion and delivery of the road and its acceptance, and the like sum semi-annually thereafter.

And on failure to pay the said sum or sums, the said party of the first part may resume said road and run the same, and in case the net earnings are insufficient to pay said rent, the said Troy and Boston Company shall be liable for the balance.

And it is further agreed and understood by and between the parties hereto, that they shall use their influence to bring about a proper and equitable consolidation of the Troy and Boston, Southern Vermont, Troy and Greenfield, Vermont and Massachusetts, and Fitchburg Railroads.

After the completion of said Hoosac Tunnel, if the Troy and Greenfield Railroad Company should run and operate the road to Pownal line, then it is agreed that the said Troy and Boston and Troy and Greenfield shall run in connection with Southern Vermont and Troy and Boston Companies solely, and divide the receipts for freight and passengers that shall pass from one railroad to the other *pro rata*,—that is, each road shall receive an equal amount for equal distance on said joint business between the village of North Adams and all points on the line of the Troy and Boston Railroad and Southern Vermont Railroad.

The Troy and Greenfield Company to furnish or provide such freight and passenger depot accommodations, turn-tables, woodshed, and water-tanks, and supply of water, as may be necessary for the convenient use of the road at Adams, and other points where necessary.

In testimony whereof the said Troy and Boston and Troy and Greenfield Railroad Companies have executed these presents by their respective presidents and secretaries, and caused their respective corporate seals to be hereunto affixed the day and year first within written.

D. N. CARPENTER,

President Troy & Greenfield R. R. Co.

W. T. DAVIS,

Clerk Troy & Greenfield R. R. Co.

D. THOS. VAIL,

President Troy & Boston R. R. Co.

JARED REED,

Secretary Troy & Boston R. R. Co.

In presence of

C. B. RUSSELL,

As witness to signatures of D. THOS. VAIL and JARED REED.

Letters relative to the acceptance of the Troy and Greenfield Railroad by the Troy and Boston Railroad Company.

WILLIAMSTOWN, February 16, 1869.

HON. T. WENTWORTH:

My Dear Sir:—I was very sorry that I was absent from home when you called. I should have been very glad to have extended to you the hospitality of my house. Your letter of inquiry has come to hand to-day. You ask "what connection the officers of the Troy and Boston Railroad had with the engineer who examined the road from North Adams to Troy." I answer this question unequivocally. That the committee appointed by the towns of Adams and Williamstown, told the directors of the Troy and Boston road that they were ignorant in regard to railroads, and would not accept of the road as completed, and issue the town scrip, till a competent engineer should examine the same, and pronounce it *good*. A day was fixed by the directors of the Troy and Boston road when they would furnish an engineer, and with him go over the road with the committees of Williamstown and Adams. We went together over the road to Troy, accompanied by Col. Haupt, but no engineer appeared. The result was that we met in the office of the Troy and Boston Railroad, in Troy, and refused "*in toto*" to accept the road. We were urged to accept it; the directors saying the road was in good order, in as good a condition as railroads were when they were pronounced in safe running order; but the committee refused to accept it till it was examined by a competent railroad engineer. Consequently, another day was fixed upon to go over the road. The committees on the part of the towns appointed a sub-committee to go over the road with the engineer; I was sick and could not go. The result was, the engineer, (Wilder, I think, is the name,) gave to the committee the certificate of approval of the finishing of the road, which you found upon our town record.

The directors of the Troy and Boston Railroad saying from the time of our first going over the road till its acceptance, that they were ready and wished to accept it; that it was in good running order. This statement will be corroborated by five other men of the committee, three of North Adams, and two of Williamstown; men of truth and character.

Thus you see it was the directors of the Troy and Boston Railroad that desired the acceptance of the road; also they furnished the engineer. Col. Haupt was equally desirous, and with the Troy

and Boston, begged its acceptance, and the issuing of the town scrip. I hope I have furnished you an answer to your inquiry.

With sentiments of respect, yours,

HENRY L. SABIN.

P. S. I do not know where Wilder now is ; but, if necessary, I can find out.

NORTH ADAMS, February 24, 1869.

MR. WENTWORTH :

Sir.—Your favor came duly to hand, and in answer, according to the best of my recollection, I think that the officers of the Troy and Boston Railroad urged the committee to issue the scrip, using language similar to this : that if they were willing to lease the road, that ought to be the best evidence that we could have, that it was all right. I think that Mr. Baker and Mr. Robinson went with the committee when Mr. Wilder passed over the road for the purpose of inspecting the road and bridges. The committee not feeling competent to judge as to the condition of the road, required H. Haupt & Co. to bring on a competent and responsible engineer to examine the road and bridges, and give the committee a statement in writing of the true condition of the road under his signature. The engineer that we choose was the superintendent of the Hudson River Railroad ; but he was called away, and Mr. Wilder was recommended to the committee, if I recollect right, by H. Haupt & Cartwright and the officers of the Troy and Boston Railroad. The road was only examined from Hoosac Falls to North Adams, as that was all the committee had anything to do with.

Respectfully yours,

JAMES HUNTER.

The Bond and Mortgage given to the State.

At a meeting of the stockholders of the Troy and Greenfield Railroad Company, held at the company's office, in Greenfield, July 26th, A. D. 1855, on motion of D. N. Carpenter, the following votes were adopted:—

Voted, That the corporation hereby accept the Act of the legislature approved April 5th, A. D. 1854, entitled, "An Act authorizing a loan of State credit to enable the Troy and Greenfield Railroad Company to construct the Hoosac Tunnel," and the directors are authorized and requested to cause to be executed by themselves, or a committee duly authorized and countersigned by the treasurer, a bond to the Commonwealth, in accordance with the provisions of the fifth section of the Act.

Voted, That the directors be, and are hereby authorized, to cause to be executed by themselves or by a committee duly authorized, and countersigned by the treasurer, a suitable instrument assigning and mortgaging to the Commonwealth the entire railroad with its income, and all the franchise and property to them belonging, as a pledge or mortgage to secure the performance of the conditions of the above named bond, in accordance with the additional provisions of the fifth section of the Act.

Voted, That the directors be authorized to assign, by themselves or by a committee duly authorized, and countersigned by the treasurer, to the Commonwealth, all the interest this corporation now has, or may hereafter obtain, in the Southern Vermont Railroad Company.

A true copy from the record.

WENDELL T. DAVIS, *Clerk*.

At a meeting of the directors of the Troy and Greenfield Railroad Company, held at the office of the company in Greenfield, July 26th, A. D. 1855,

Voted, That Otis Clapp and William A. Galbraith, with the treasurer, be a committee authorized, in the name and behalf of this corporation to execute any bond, mortgage or other instrument required by the fifth section of the Act entitled "An Act authorizing a loan of the State credit to enable the Troy and Greenfield Railroad Company to construct the Hoosac Tunnel," and approved by the governor April 5th, 1854, or any other papers necessary to secure the full benefit of the said Act, agreeably to a vote of the stockholders passed this day.

A true copy from the record.

WENDELL T. DAVIS, *Clerk*.

At a meeting of the board of directors of the Troy and Greenfield Railroad Company, duly held in Greenfield, on the 27th day of February, A. D. 1855,—

Wendell T. Davis was by ballot duly chosen clerk and treasurer of the Troy and Greenfield Railroad Corporation, and was sworn to the faithful discharge of the duties of said offices.

A true copy from the record. WENDELL T. DAVIS, *Clerk*.

Know all men by these Presents, That the Troy and Greenfield Railroad Company is held, and stands firmly bound unto the Commonwealth of Massachusetts, in the full and just sum of four million dollars, to the payment of which said sum, well and truly to be made, the Troy and Greenfield Railroad Company binds itself and its successors, unto the Commonwealth of Massachusetts and its assigns, firmly by these presents.

In witness whereof, the Troy and Greenfield Railroad Company has caused its seal to be hereunto affixed, and these presents to be signed by a committee and its treasurer, this twenty-eighth day of July, in the year of our Lord one thousand eight hundred and fifty-five, (28th July, A. D. 1855.)

The condition of this obligation is such that, whereas, in and by an Act of the Commonwealth of Massachusetts, approved on the fifth day of April, A. D. eighteen hundred and fifty-four, entitled "An Act authorizing a loan of the State credit to enable the Troy and Greenfield Railroad Company to construct the Hoosac Tunnel," it is enacted as follows, viz. :—

Be it enacted by the Senate and House of Representatives, in General Court assembled, and by the authority of the same, as follows :—

SECT. 1. The treasurer of the Commonwealth is hereby authorized and instructed to issue scrip, or certificates of debt, in the name and in behalf of the Commonwealth, and under his signature and the seal of the Commonwealth, for the sum of two millions of dollars, which may be expressed in the currency of Great Britain, and may be payable to the bearer thereof in London, and bearing an interest of five per cent. per annum, payable semi-annually in London, on the first days of April and October; or the said scrip may be issued in federal currency payable in Boston, as the directors of the Troy and Greenfield Railroad Company shall elect, when they apply for each and every issue of said scrip, with warrants for the interest attached thereto, signed by the treasurer; which scrip or certificates in the currency of Great Britain shall be redeemable in

London, and those in the federal currency at Boston, at the end of thirty years from the date thereof, and the same shall bear date on the first days of April or October which shall precede the issue of each portion of said scrip; and all such scrip shall be countersigned by the governor of the Commonwealth, and be deemed a pledge of the faith and credit of the Commonwealth for the redemption thereof; and the treasurer of the Commonwealth, under the conditions hereinafter provided, shall deliver the same to the treasurer of the Troy and Greenfield Railroad Company, for the purpose of enabling the said company to construct a tunnel and railroad under and through the Hoosac Mountain, in some place between the "Great Bend" in Deerfield River, in the town of Florida, at the base of Hoosac Mountain, on the east, and the base of the western side of the mountain, near the east end of the village of North Adams, on the west.

SECT. 2. Whenever it shall be made to appear, to the satisfaction of the governor and council, that the Troy and Greenfield Railroad Company shall have obtained subscriptions to their corporate stock in the sum of six hundred thousand dollars, and twenty per cent. on each and every share of said six hundred thousand dollars shall have been actually paid in, and shall have completed seven miles of their said railroad, in one or two sections, and one thousand lineal feet of their said tunnel under the Hoosac, in one or more sections of size sufficient for one or more railroad tracks, a portion of said scrip, to the amount of one hundred thousand dollars, shall be delivered to the treasurer of said company; and when said company shall have completed, in one or two sections, ten miles of their said railroad and two thousand lineal feet of their said tunnel, in one or more sections, another portion of said scrip, to the amount of one hundred thousand dollars, shall be delivered to the treasurer of said company; and when said company shall have completed fifteen miles of their said railroad, in one or two sections, and three thousand lineal feet of their said tunnel, in one or more sections, another portion of said scrip, amounting to one hundred thousand dollars, shall be delivered to the treasurer of said company; and when said company shall have completed twenty miles of their said railroad, in one or two sections, and four thousand lineal feet of their said tunnel, in one or more sections, another portion of said scrip, amounting to one hundred thousand dollars, shall be delivered to the treasurer of said company; and when said company shall have completed twenty-five miles of their said railroad, in one or two sections, and five thousand lineal feet of their said tunnel, in one or more sections, another portion of said scrip, amounting to

one hundred thousand dollars, shall be delivered to the treasurer of said company; and when said company shall have completed thirty miles of their said railroad, in one or two sections, and six thousand lineal feet of their said tunnel, in one or more sections, another portion of said scrip, amounting to one hundred thousand dollars, shall be delivered to the treasurer of said company; and when said company shall have completed thirty-two miles of their said railroad, in one or two sections, including all their line to be constructed east of the town of Florida, and seven thousand lineal feet of their said tunnel, in one or more sections, another portion of said scrip, amounting to one hundred thousand dollars, shall be delivered to the treasurer of said company; and for each additional portion or portions of said tunnel of fifteen hundred lineal feet, in one or more sections, completed by said company, another portion of said scrip, amounting to one hundred thousand dollars, shall be delivered to the treasurer of said company; subject, however, to this proviso, that the last two hundred thousand dollars of said scrip, shall be reserved until said company, their successors or their representatives, have opened said railroad for use through the Hoosac, and laid a continuous railroad from Greenfield to the line of the State in Williamstown, when the same shall be delivered: *provided*, that, prior to the second delivery of scrip to the treasurer of the Troy and Greenfield Railroad Corporation, according to the provisions of this section, evidence shall be furnished, satisfactory to the governor and council, that a sum equal to thirty per cent. of the amount of the scrip then applied for shall have been actually paid to the treasurer of said corporation (in cash) by the stockholders thereof, in addition to the hundred and twenty thousand dollars to be paid prior to the delivery of any scrip; and that, on each application for scrip in pursuance of the provisions of this section, and prior to the delivery thereof, satisfactory evidence shall be furnished to the governor and council that a sum equal to thirty per cent. of the amount of scrip then applied for has been actually paid to the treasurer of said corporation, until six hundred thousand dollars subscribed for have been paid by the stockholders. And no scrip shall be delivered till satisfactory evidence of such payment is, from time to time, furnished to the governor and council.

SECT. 3. Whenever the treasurer of said company shall receive any of said scrip, he shall within three months from the receipt of the same, pay to the commissioners of the sinking fund by this Act hereafter established, ten per cent. on the amount of the scrip so taken, as a sinking fund; and after the whole of said road is open for use, twenty-five thousand dollars annually shall be set apart

from the income of said railroad and paid to said commissioners, and the whole thereof shall be added to said sinking fund, and shall be managed, invested and appropriated as is or shall be provided by law in relation thereto.

SECT. 4. The treasurer of the Commonwealth, the auditor of accounts of the Commonwealth, and the treasurer of the Troy and Greenfield Railroad Company, for the time being, shall be the commissioners of the sinking fund of the Troy and Greenfield Railroad Company. The said commissioners shall have the care and management of all the moneys, funds and securities at any time belonging to said sinking fund, and shall invest the same; but the moneys not invested and all the securities of said fund shall be in the custody of the treasurer of said Commonwealth.

SECT. 5. This act shall not take effect until said company, at an annual meeting, or at a special meeting, duly notified for that purpose, shall have assented to the provisions thereof and shall have executed to the Commonwealth a bond, in such form as the attorney-general prescribed on the issuing of scrip to the Western Railroad Corporation, conditioned that the Troy and Greenfield Railroad Company shall comply with the provisions of this act and shall faithfully expend the proceeds of said scrip as herein provided, and shall indemnify and save harmless the Commonwealth from all loss or inconvenience on account of said scrip; and that said company shall well and truly pay the principal sum of said scrip punctually when the same shall become due and payable, or such part thereof as the sinking fund aforesaid shall be insufficient to pay, and the interest thereon semi-annually as the same shall fall due, and shall also assign to the Commonwealth by suitable instrument or instruments of the same form with that or those prepared by the attorney-general on the issuing of scrip to the Western Railroad Corporation the entire railroad of said corporation, with its income and all the franchise and property to them belonging, the whole thereof to be held by the Commonwealth as a pledge or mortgage to secure the performance of all the conditions of said bond: *provided, however*, that the Commonwealth shall not take possession of said pledged or mortgaged property or any part thereof, under or by virtue of said mortgage, unless for some substantial breach of some condition of said bond.

SECT. 6. In addition to the security provided in the preceding section, the said company shall assign all the interest they now have or may hereafter obtain, in the Southern Vermont Railroad Company.

SECT. 7. The Troy and Greenfield Railroad Company are authorized at any time prior to the execution of said mortgage and within

one year from the passage of this act, to alter the present location of their road: *provided*, that the tunnel shall be located and constructed within the limits prescribed by the first section of this act.

SECT. 8. The time for completing the Troy and Greenfield Railroad is hereby extended for the additional term of six years.

SECT. 9. When the Commonwealth shall have advanced to said company said bonds or scrip to the amount of five hundred thousand dollars, the legislature may elect two directors of said company, who shall hold office for the same time, be elected in the same manner, and receive compensation to the same amount, as the state directors of the Western Railroad Corporation, but neither of them, while holding such office, shall serve as a director of any other railroad company.

HOUSE OF REPRESENTATIVES, April 3, 1854.

Passed to be enacted:

OTIS P. LORD, *Speaker*.

IN SENATE, April 4, 1854.

Passed to be enacted:

CHARLES EDW. COOK, *President*.

April 5, 1854. Approved:

EMORY WASHBURN, *Governor*.

Now, therefore, the condition of the above obligation is such that if the said Troy and Greenfield Railroad Company shall comply with the requisitions of this Act and shall faithfully expend the proceeds of said scrip in the construction of their road, as provided in said Act, and shall indemnify and save harmless the Commonwealth from all loss or inconvenience on account of said scrip or certificates of debt; and if said corporation shall and will pay the principal sum of said scrip or certificates which may be delivered to their treasurer, punctually, when the same shall become due, or such part thereof as the sinking fund may be insufficient to pay, and the interest thereon semi-annually as the same shall fall due, then and on the above conditions the foregoing obligation shall be void and of no effect, but shall otherwise remain in full force and virtue.

OTIS CLAPP.

[SEAL.]

WM. A. GALBRAITH.

WENDELL T. DAVIS, *Treasurer*.

Executed and delivered in presence of

JOHN L. ANDREWS.

J. H. CHOATE.

Know all men by these Presents, That the Troy and Greenfield Railroad Company, in consideration of the sum of two millions of dollars paid, or to be paid, by the Commonwealth of Massachusetts, according to the provisions of a certain Act of the said Commonwealth, approved on the fifth day of April, A. D. 1854, entitled, "An Act authorizing a loan of the State credit to enable the Troy and Greenfield Railroad Company to construct the Hoosac Tunnel," does hereby give, grant, bargain, sell, and convey, unto the Commonwealth of Massachusetts, the entire railroad of said corporation, with its franchises, income and property. Also, there is hereby assigned and conveyed all the interest which the said Troy and Greenfield Railroad Company now has, or may, or shall at any time hereafter have or obtain in the Southern Vermont Railroad Company.

The intent and meaning hereof being that this conveyance shall as against any claims or incumbrances to which the said road, franchise or property may be hereafter subjected, operate to cover and bind any and all lands included within the location of the said road, the title to which or the easement upon which shall be hereafter acquired, and any and all additions which shall be made hereafter to said road by labor, materials or otherwise, and any lands hereafter purchased and appropriated for depots for said road, or any building or fixture placed thereon, and also any engines, cars, or other apparatus which may be placed on said road or procured therefor as fully as if the said road had been completed, and all the property acquired and owned by said corporation at the time of the execution of this conveyance, together with all the interest the said corporation now has, or may, or shall at any time hereafter obtain or have in the Southern Vermont Railroad Company, provided that this conveyance shall not be construed to include or affect any personal property which shall have been sold by said corporation to a *bona fide* purchaser, before the Commonwealth shall take possession thereof under this conveyance.

To have and to hold the said entire railroad, income, property and franchise of the said Troy and Greenfield Railroad Company, with such interest as said company now has, or may, or shall hereafter have or obtain in the Southern Vermont Railroad Company, to the Commonwealth of Massachusetts, and its assigns, to their use and behoof forever.

Provided, nevertheless, that whereas, in and by the aforesaid Act of the Commonwealth of Massachusetts, the treasurer of the Commonwealth is authorized and instructed to issue scrip or certificates

of debt in the name and behalf of the Commonwealth, and under his signature and the seal of the Commonwealth for the sum of two million dollars, which may be expressed in the currency of Great Britain, and may be payable to the bearer thereof in London and bearing an interest of five per cent. per annum, payable semi-annually in London on the first days of April and October, or the said scrip may be issued in federal currency payable in Boston, as the directors of the Troy and Greenfield Railroad Company shall elect when they apply for each and every issue of said scrip, with warrants for the interest attached thereto signed by the treasurer; which scrip or certificates in the currency of Great Britain shall be redeemable in London, and those in the federal currency in Boston at the end of thirty years from the date thereof, and shall be countersigned by the governor of the Commonwealth and be deemed a pledge of the faith and credit of the Commonwealth for the redemption thereof; and that the treasurer of the Commonwealth shall, under the conditions thereafter provided, deliver the same to the treasurer of the Troy and Greenfield Railroad Company for the purpose of enabling said company to construct the Hoosac Tunnel.

And whereas, provision is made in said Act for the creation of a sinking fund for the future purchase or final redemption of said scrip; and whereas, it is also provided that no part of said scrip shall be delivered to the treasurer of said corporation until said corporation shall have executed to the Commonwealth a bond in such form as was prescribed by the attorney-general on the issuing of scrip to the Western Railroad Corporation, conditioned that said Troy and Greenfield Railroad Company shall comply with the provisions of said Act, and shall faithfully expend the proceeds of said scrip as therein provided, and shall indemnify and save harmless the Commonwealth from all loss or inconvenience on account of said scrip, and shall well and truly pay the principal sum of said scrip punctually when the same shall become due and payable, or such part as the sinking fund aforesaid shall be insufficient to pay, and the interest thereon semi-annually as the same shall fall due, and shall also assign to the Commonwealth, by suitable instrument or instruments of the same form with that of those prepared by the attorney-general on the issuing of scrip to the Western Railroad Corporation, their entire railroad, with its income and all the franchise and property to them belonging, as a pledge or mortgage to secure the performance of all the conditions of said bond, and also to assign all the interest said Troy and Greenfield Railroad Company

now has or may at any time hereafter obtain in the Southern Vermont Railroad Company.

And whereas, the Troy and Greenfield Railroad Company has executed to the Commonwealth the bond aforesaid, bearing even date herewith, now therefore, if the Troy and Greenfield Railroad Company shall well and truly keep and perform the conditions of said bond according to their true meaning and intent, then this deed and the bond aforesaid shall both be void, but otherwise shall remain in full force and virtue.

And provided, also, that the Commonwealth shall not take possession of said pledged or mortgaged property unless for a substantial breach of some condition of said bond.

And the Troy and Greenfield Railroad Company, for the consideration aforesaid, covenants with the Commonwealth of Massachusetts and its assigns, that the said corporation will at any time or times hereafter, on reasonable notice and request, execute any other and further instrument or assurance that the attorney-general of the Commonwealth for the time being shall advise to be necessary and proper to secure the Commonwealth or its assigns according to the true intent and purpose of the Act aforesaid.

In witness thereof, the Troy and Greenfield Railroad Company has caused its seal to be hereto affixed and these presents to be signed in its behalf by Otis Clapp, Wm. A. Galbraith and Wendell T. Davis, a committee duly authorized and appointed for that purpose, and also to be countersigned by said Wendell T. Davis, the treasurer of said corporation, this twenty-eighth day of July, A. D. eighteen hundred and fifty-five.

OTIS CLAPP.

[SEAL.]

WM. A. GALBRAITH.

WENDELL T. DAVIS, *Treasurer*.

Executed and delivered in the presence of

JOHN L. ANDREWS.

J. H. CHOATE.

COMMONWEALTH OF MASSACHUSETTS.

SUFFOLK COUNTY, ss. Be it known, that on this twenty-eighth day of July, A. D. eighteen hundred and fifty-five, then appeared before me the within named Otis Clapp, William A. Galbraith and Wendell T. Davis on behalf of the Troy and Greenfield Railroad Company, and acknowledged the within and foregoing instrument to be the act and deed of the Troy and Greenfield Railroad Company.

Before me, JOHN L. ANDREWS, *Justice of the Peace*.

COMMONWEALTH OF MASSACHUSETTS.

ATTORNEY-GENERAL'S OFFICE, }
August 1, 1855. }

I have examined the foregoing bond and mortgage, and find them both to be drawn in accordance with the form prescribed and approved by the attorney-general on the issuing of scrip to the Western Railroad Corporation, as required by the Act of the year 1854, entitled, "An Act authorizing the loan of the State credit to enable the Troy and Greenfield Railroad Company to construct the Hoosac Tunnel."

Attest, JOHN H. CLIFFORD, *Attorney-General*.

FRANKLIN, ss. Received August 6th, 1855. Recorded in book No. 195, page 52, and compared by

ALMON BRAINARD, *Reg'r*.

BERKSHIRE, ss. LANESBOROUGH, August 20th, 1855, 5h. 0m. P. M. Received and recorded in book No. 80, pages 292, 3, 4, 5, 6, and 7, and examined by

RICHARD WHITNEY, *Reg'r*.

A true copy of the original. Attest, DAVID PULSIFER.

Mortgage of the Troy and Greenfield Railroad Company to the Commonwealth.

Know all men by these Presents: That whereas in and by an Act of the general court of the Commonwealth of Massachusetts, approved by the governor on the fourth day of April last past, entitled, "An Act in addition to an Act authorizing a loan of the State credit to enable the Troy and Greenfield Railroad Company to construct the Hoosac Tunnel," the said railroad company are required to file a location of their entire road and tunnel in the manner and form in the said Act prescribed; *and whereas*, it is also provided in said Act that no delivery of the State scrip heretofore authorized to be delivered to said company shall be made until such location shall have been duly made, and said company shall have executed to the Commonwealth such further bond and mortgage or other assurance of title on their franchise, railroad or other property, as the attorney-general shall prescribe for the further security of the Commonwealth; *and whereas*, the said company have fully complied with all the requirements of said Act, in relation to the making and filing of said location :

Now, therefore, the said Troy and Greenfield Railroad Company, a corporation established by law, in consideration of two millions of dollars paid or to be paid by the Commonwealth of Massachusetts, according to the provisions of the several Acts relating thereto, does hereby give, grant, bargain, sell, convey and confirm unto the said Commonwealth of Massachusetts, the entire railroad of said corporation, and all its franchises and property whatsoever, and doth hereby ratify and confirm all bonds, mortgages, and other conveyances and assurances heretofore executed and delivered by said corporation to said Commonwealth. The intent and meaning hereof being to convey and confirm as aforesaid to said Commonwealth, all lands, buildings and tenements, and all interests and easements therein that said corporation now has, or hereafter may acquire within the limits of the location made and filed as aforesaid, and to confirm all former conveyances, bonds and mortgages heretofore made, as aforesaid. Provided that this conveyance shall not be construed to include or effect any personal property which shall have been sold by said corporation to a bona fide purchaser, before the Commonwealth shall take possession thereof under this or some other conveyance.

To have and to hold, the franchises, property and premises, hereby conveyed to the said Commonwealth and its assigns, to their use and behoof forever.

Provided, nevertheless, that if the said Troy and Greenfield Railroad Company shall well and truly do and perform all and every the obligations, duties, covenants and agreements, by them heretofore undertaken, covenanted and agreed to be done and performed, in the several bonds, mortgages and conveyances, heretofore made and delivered by them to said Commonwealth, and shall, also, well and truly do, perform and observe all the terms, conditions and requirements of the several Acts of the general court, heretofore passed, or that may be hereafter passed, relating to said railroad and tunnel, and to the loan of the State credit in aid thereof, and shall also execute and deliver to said Commonwealth or its assigns, any other or further assurances, conveyances or instruments that the attorney-general of said Commonwealth for the time being shall advise to be necessary to secure the Commonwealth or its assigns, according to the true intent and purpose of said several Acts, upon reasonable notice, then this deed shall be void; otherwise in full force and virtue.

In witness whereof, the said Troy and Greenfield Railroad Company has caused its corporate seal to be hereto affixed, and these presents to be signed by D. N. Carpenter, H. Haupt, and E. G. Lamson, in its behalf, a committee duly authorized and appointed for that purpose, and also to be countersigned by Wendell T. Davis, its treasurer, this sixth day of July, in the year one thousand eight hundred and sixty.

D. N. CARPENTER.

H. HAUPT. [SEAL.]

E. G. LAMSON.

Countersigned, WENDELL T. DAVIS, Treasurer Troy and Greenfield Railroad Company.

In presence of H. HARLEY, witness to D. N. Carpenter, H. Haupt, and W. T. Davis.

Witness to signature of E. G. Lamson, F. A. BALL.

COMMONWEALTH OF MASSACHUSETTS.

Franklin, ss., July 9th, A. D. 1860. This day appeared personally the said David N. Carpenter, Herman Haupt, and Wendell T. Davis, and acknowledged the foregoing to be the free act and deed of the said Troy and Greenfield Railroad Company.

Before me, GEO. GRENNELL, *Justice of the Peace.*

Franklin, ss. Received July 20, 1860. Recorded and examined by HUMPHREY STEVENS, *Register.*

A copy (as recorded in Book 226, page 76.)

Attest,

HUMPHREY STEVENS, *Register.*

Mortgage of the Troy and Greenfield Railroad Company to the Commonwealth.

Know all men by these Presents, That the Troy and Greenfield Railroad Company, a corporation established by law, in consideration of the sum of one dollar and other valuable consideration to the said corporation paid by the Commonwealth of Massachusetts, the receipt whereof is hereby acknowledged, does hereby give, grant, bargain, sell, convey and confirm to the said Commonwealth of Massachusetts, all the franchises and property whatsoever, real, personal, and mixed, of said Troy and Greenfield Railroad Company.

To have and to hold the said franchises and property, real, personal and mixed, above granted, to the said Commonwealth and its assigns, to their use and behoof forever.

Provided, nevertheless, that if the said Troy and Greenfield Railroad Company shall well and truly do and perform all and every the obligations, duties, covenants and agreements by them heretofore undertaken, covenanted and agreed to be done and performed in the several bonds, mortgages and conveyances heretofore made and delivered by them to said Commonwealth, and shall also well and truly do and perform and observe all the terms, conditions and requirements of the several Acts of the general court of said Commonwealth heretofore passed, then this deed shall be void, otherwise in full force and virtue.

In witness whereof, the said Troy and Greenfield Railroad Company has caused its corporate seal to be hereto affixed, and these presents to be signed by Alvah Crocker, president of said corporation, thereto duly authorized, this fifth day of April, eighteen hundred and sixty-two.

TROY AND GREENFIELD RAILROAD COMPANY,
By ALVAH CROCKER, *President.* [SEAL.]

Executed in presence of
HENRY WINN.

SUFFOLK, ss., April 7, 1862.

Then personally appeared Alvah Crocker, President of the Troy and Greenfield Railroad Company, and acknowledged the foregoing instrument by him executed, to be the free act and deed of said corporation.

Before me,

DWIGHT FOSTER, *Justice of the Peace.*

TROY AND GREENFIELD RAILROAD ACTS.

[Chapter 307, Acts of 1848.]

AN ACT TO INCORPORATE THE TROY AND GREENFIELD RAILROAD COMPANY.

Be it enacted by the Senate and House of Representatives, in General Court assembled, and by the authority of the same, as follows:—

SECT. 1. George Grennell, Roger H. Leavitt, Samuel H. Reed, their associates and successors, are hereby made a corporation, by the name of the Troy and Greenfield Railroad Company, with all the powers and privileges, and subject to all the duties, liabilities and restrictions, set forth in the forty-fourth chapter of the Revised Statutes, and in that part of the thirty-ninth chapter thereof relating to railroad corporations, and in all other general laws which have been, or shall be hereafter passed, relative to railroad corporations.

SECT. 2. Said company are hereby authorized to locate, construct and maintain a railroad, with one or more tracks, from some convenient point on the Vermont and Massachusetts Railroad, at or near the termination of said railroad in Greenfield, through any or all of the following towns, viz.: Greenfield, Deerfield, Conway, Shelburne, Buckland, Coleraine, Charlemont, Hawley, Rowe and Monroe, in the county of Franklin, and Savoy, Florida, Adams, Clarksburg and Williamstown, in the county of Berkshire, to some point on the line of the State of New York or of Vermont, convenient to meet, or connect with any railroad that may be constructed from any point at or near the city of Troy, on the Hudson River, in the State of New York.

SECT. 3. The said company may, with their railroad, unite with, and enter upon, the Vermont and Massachusetts Railroad, at or near the termination thereof, as aforesaid, and may likewise enter upon, cross, and use, the railroad of the Connecticut River Railroad Company, in and near the town of Greenfield, (not, however, interfering with the depot buildings of either of said companies,) on such terms as may be agreed upon between the corporation hereby created and the aforesaid companies respectively, or as may be prescribed by law.

SECT. 4. The capital stock of the said company shall consist of not more than thirty-five thousand shares, the number of which shall, from time to time, be determined by the directors thereof; and no assessment shall be laid of a greater amount thereon, in the whole, than one hundred dollars on each share. And the said

company may purchase and hold such real and personal estate, as may be necessary for the purposes of their incorporation.

SECT. 5. If the location of said road shall not be filed within two years, in the manner prescribed by law, or if the said railroad shall not be constructed within seven years from the passage of this act, then the same shall be void.

SECT. 6. The legislature may authorize any railroad company to enter, with their railroad, upon the Troy and Greenfield Railroad, on such terms as may be agreed upon by said companies, or as may be prescribed by the provisions of law.

SECT. 7. The legislature may, after the expiration of five years from the time when such railroad shall be opened for use, from time to time, alter and reduce the rate of toll or profits upon said road; but said toll shall not be so reduced without the consent of said company, as to produce, with said profits, less than ten per cent. per annum, upon the investments of the said company.

SECT. 8. The said corporation may contract with the owners of any contiguous railroad leading into or from either of the States of Vermont or New York, for the use of the whole or any part thereof, or for the running and operating the two railroads conjointly, or for the leasing of such contiguous road, or for the letting or hiring of their own road to the owners of such contiguous road, or of any other road which composes a part of the railroad line between the cities of Boston and Troy, of which the railroad hereby authorized shall be a part.

SECT. 9. The Troy and Greenfield Railroad Company shall, within one year after the opening of their road for use, purchase and take an assignment of the lease and contract of transportation, made and executed between the Western Railroad Corporation and the Pittsfield and North Adams Railroad Corporation on the thirtieth day of January, in the year one thousand eight hundred and forty-six; and shall have all the advantages, and assume all the liabilities, accruing under and by virtue of said lease: *provided*, that the said Western Railroad Corporation shall perform their covenants in said lease, to keep said road, and other property therewith connected, in repair, until such assignment; and shall, within six months after the said Troy and Greenfield Railroad Company shall have filed the location of their road according to law, and shall have raised by subscription, one million of dollars, for the construction of the same, signify in writing, their election to make such assignment: *and provided*, that at the time of such assignment, there shall be secured to said Western Railroad Corporation, by a proper instrument, a lien or mortgage upon all their rights in said Pittsfield and

North Adams Railroad, as collateral security for the performance of all the obligations of said corporation, contained in said lease and contract of transportation; *and, provided also*, that after the completion of the said Troy and Greenfield Railroad the said Western Railroad Corporation shall assign and convey to the said Troy and Greenfield Railroad Company, the said contract of transportation, according to the terms of this section, if the said Troy and Greenfield Railroad Company shall so elect.

SECT. 10. This act shall take effect from and after its passage.

[*Approved May 10, 1848.*]

[Chapter 108, Acts of 1849.]

AN ACT CONCERNING THE TROY AND GREENFIELD RAILROAD.

The Troy and Greenfield Railroad Corporation are hereby authorized to vary the location of their road, as defined in their charter, so that the same may be located and constructed through the towns of Ashfield and Plainfield.—[*Approved April 17, 1849.*]

[Chapter 312, Acts of 1850.]

AN ACT TO EXTEND THE TIME FOR LOCATING THE TROY AND GREENFIELD RAILROAD.

The time within which the location of the Troy and Greenfield Railroad may be filed, is hereby extended to the first day of December next.—[*Approved May 3, 1850.*]

[Chapter 40, Acts of 1852.]

AN ACT TO AUTHORIZE THE TROY AND GREENFIELD RAILROAD COMPANY TO HOLD ITS ANNUAL MEETING IN APRIL.

SECT. 1. The Troy and Greenfield Railroad Company are hereby authorized to hold their annual meeting for the current year, for the choice of officers and the transaction of such other business as may be specified in the warrant therefor, at such time during the month of April as the directors may designate, anything in the by-laws of said company to the contrary notwithstanding.

SECT. 2. Notice of said meeting shall be given in the manner prescribed by the by-laws of said company.

SECT. 3. This act shall take effect from and after its passage.

[*Approved March 18, 1852.*]

[Chapter 297, Acts of 1852.]

AN ACT CONCERNING THE TROY AND GREENFIELD RAILROAD COMPANY.

SECT. 1. The Troy and Greenfield Railroad Company and the Southern Vermont Railroad Company, a corporation established by the laws of Vermont, are hereby authorized by a vote of the stockholders now, or to be, passed, to unite themselves in one corporation; and such vote having been passed, they shall thereupon become one corporation, and all the franchises, property, powers and privileges now enjoyed by, and all the restrictions, liabilities, and obligations imposed upon, said two corporations, by virtue of their respective charters, shall appertain to said united corporation in the same manner as if the same had been contained in or required under an original charter. Such corporation so formed by such union, shall be called by the name of the Troy and Greenfield Railroad Company.

SECT. 2. If the Troy and Greenfield Railroad Company shall unite with said Southern Vermont Railroad Company, then, and in that case, one or more of the directors of such corporation, formed by such union, shall be an inhabitant of this Commonwealth, on whom processes against such corporation may be legally served, and said company shall be held answerable to answer in the jurisdiction where the service is made and the process returnable.

SECT. 3. The said company and the stockholders therein so far as they are situate in Massachusetts, shall be subject to all the duties and liabilities of railroad corporations in Massachusetts, and to the general laws of the Commonwealth in relation to railroad corporations. [*Approved May 20, 1852.*]

[Chapter 294, Acts of 1855.]

AN ACT TO AUTHORIZE CERTAIN TOWNS IN THE COUNTIES OF FRANKLIN AND BERKSHIRE TO SUBSCRIBE TO THE CAPITAL STOCK OF THE TROY AND GREENFIELD RAILROAD COMPANY.

SECT. 1. That each of the several towns of Ashfield, Buckland, Conway, Coleraine, Charlemont, Deerfield, Greenfield, Hawley, Heath, Monroe, Rowe and Shelburne, in the county of Franklin, and each of the several towns of Adams, Florida and Williamstown, in the county of Berkshire, be, and hereby is, authorized to subscribe for and hold shares in the capital stock of the Troy and Greenfield Railroad Company, to any amount of money not exceeding three per centum on the amount of its last valuation: *provided*, the inhabitants of such town or towns, at a legal town meeting,

duly called for that purpose, shall vote by a two-thirds vote to subscribe for such shares in accordance with the terms of this act, to pay for the same out of the town treasury, and to hold the same as town property, subject to the disposition of the town, for public purposes, in like manner as any other property which it may possess.

SECT. 2. Said towns are hereby authorized to raise, by loans or taxes, any sums of money which shall be required to pay the instalments on their respective subscription to said stock and interest thereon.

SECT. 3. This act shall take effect from and after its passage.

[*Approved May 18, 1855.*]

[Chapter 237, Acts of 1856.]

AN ACT AUTHORIZING THE TROY AND GREENFIELD RAILROAD COMPANY
TO CHANGE LOCATION.

SECT. 1. The Troy and Greenfield Railroad Company are hereby authorized to change their location on the main route, at such places as will, in the opinion of the chief engineer, improve the line of the road, shorten the same, and diminish the cost of construction: *provided*, the *termini* of said road shall not be changed.

SECT. 2. Such changes as are made under the provisions of the first section of this act, shall be filed in the clerk's office, for the counties of Franklin and Berkshire, within one year from the time they are made.

SECT. 3. All owners of land, over which this railroad has been located, shall have the right to claim and have their damages assessed, any time within three years from the passage of this act.

[*Approved May 31, 1856.*]

SOUTHERN VERMONT RAILROAD.

Lease of the Southern Vermont Railroad to the Troy and Boston Railroad Company.

These Articles of Agreement, made this twenty-first day of November, A. D. one thousand eight hundred and fifty-six, between the Southern Vermont Railroad Company, of the State of Vermont, party of the first part, and the Troy and Boston Railroad Company, of the State of New York, party of the second part, witnesseth

That, *whereas*, the said Corporation, party of the first part, has been erected by the laws of Vermont and duly authorized to construct a railroad from some point on the southern line of said State, in the county of Bennington or Windham, to some point in the western line of the State, in the county of Bennington; and, *whereas*, said Southern Vermont Railroad Corporation has contracted with H. Haupt & Co. for the building and completion of their said railroad, and it is now desirable that some arrangement shall be made for bringing the said road into use, when finished; now, therefore, in consideration of the premises, the parties hereto, for adequate considerations by them interchangeably received have mutually and respectively agreed, each with the other, as follows, namely:

The said party of the first part doth hereby lease and let unto the party of the second part, for and during the term of the continuance of the charter of said Southern Vermont Railroad Corporation, and for and during the term or terms of any renewal or renewals of said charter that may hereafter be obtained, their railroad, when finished, extending from its intersection with the Troy and Greenfield Railroad on the east, to the point of intersection with the Troy and Boston Railroad on the west, together with all the lands, depot houses, water-tanks, or other structures, belonging, or that may hereafter belong, to said Corporation, the party of the first part. The railroad hereby leased shall be well and substantially built, and in conformity with the specifications in the contract between said H. Haupt & Co. and the Troy and Greenfield Railroad Company of Massachusetts; no curves shall be used of less than sixteen hundred and thirty-eight feet radius; there shall be no

ascending grades westward exceeding $\frac{6}{100}$ of a foot per one hundred feet, and no grades on any part of the road exceeding those on the Troy and Boston Railroad. It being understood and allowed, however, that until the completion of the Hoosac Tunnel, timber abutments for bridges on each bank of the Hoosac River may be used, and that a six degree curve may be used to avoid the through cut at or near the State line of Massachusetts at the eastern end of the road.

The sum of one thousand dollars to be expended under the direction of the Superintendent of the Troy and Boston Railroad Company in the construction of sheds, water-tanks and other fixtures.

And the said Troy and Boston Railroad Company, upon the completion of said Southern Vermont Railroad and its acceptance, for its part agrees and binds itself as follows, namely: That it will pay or cause to be paid to the said Southern Vermont Railroad Company for the use of said railroad and fixtures, the sum of twelve thousand dollars per annum, as follows: At the Bank of Commerce, New York City, the interest coupons on such bonds as the Southern Vermont Railroad Company shall issue in payment for construction of said road, which sum shall not exceed one hundred and fifty thousand dollars at an interest not to exceed six per cent. per annum, the principal payable in not less than twenty years from the first of May next. The balance of the twelve thousand dollars payable semi-annually at their office in the city of Troy, and such interest as shall have accrued on said bonds before delivery of said road shall be paid by said Southern Vermont Railroad Company.

In case the party of the second part should fail to make the said payments, or any, or either of them, then and in that case the said party of the first part may resume possession of said railroad, use the same, and if the net receipts thereof shall not be sufficient to pay the rent the said party of the second part shall make up the deficiency as also all damages resulting from said non-payment.

And it is further agreed between the parties hereto that they shall use their influence for a proper and equitable consolidation between the Troy and Boston Railroad, the Southern Vermont Railroad, the Troy and Greenfield Railroad, the Vermont and Massachusetts Railroad, and the Fitchburg Railroad, and in the event of a consolidation the Southern Vermont Railroad shall be valued at the average per mile of the balance of the line, and further, it is agreed that the rates of toll to be charged on through business by said Troy and Boston Railroad Company after the completion of said Hoosac Tunnel shall not exceed the proportion according to the

length of road over which said business is carried with the remainder of the route to Boston, and in case of consolidation of the lines of road as aforesaid, if within ten years, then the party of the first part shall refund to the said party of the second part the excess over nine thousand dollars per annum, (\$3,000) until the completion of the tunnel, and which excess shall be paid in cash, in instalments of three thousand dollars per annum after consolidation, with interest from that time.

It is also agreed that the temporary structures and location, agreed to in this contract, shall be changed and reconstructed in a permanent and satisfactory manner, at or before the time of completion of the Hoosac Tunnel, and if not so completed within one year from that time the Troy and Boston Company shall have the right to make the alterations, and reserve three thousand dollars per annum from the pay, to be applied to this object until completed.

The said road and fixtures to be kept in good repair, at the expense of said party of the second part, during the continuance of the lease, except that in case of casualty happening to the temporary structures herein before named, then and in that case the expense of repairs shall be borne by said Southern Vermont Railroad Company.

This contract not to be binding upon said party of the second part until a lease of that portion of the Troy and Greenfield Railroad between North Adams and the Vermont State line is executed. The party of the first part shall complete and deliver the said road to the party of the second part, if possible, on or before September 1st, 1857, and if not so completed and delivered before the first day of October, 1857, then and in that case the party of the second part shall not be required to accept the same before the first day of March, 1858.

In testimony whereof the said Troy and Boston and Southern Vermont Railroad Companies have hereunto caused to be affixed their respective corporate seals, with the signatures of their presidents and clerks, respectively the day and year first within written.

[SEAL.]

D. THS. VAIL,

Pres. Troy and Boston R. R. Co.

JARED S. WEED,

Sec'y Troy and Boston R. R. Co.

In presence of

C. B. RUSSELL,

As to signatures of D. THOS. VAIL and JARED S. WEED.

STATE OF NEW YORK.

Rensselaer County, ss.

On the 27th day of April, 1860, before me personally appeared D. Thomas Vail, to me well known, who being by me duly sworn, did testify that he resides in the city of Troy, in said county, and is, and ever since the date of the instrument within, has been, the President of the Troy and Boston Railroad Company; that he knows the corporate seal of said company, and that the seal affixed to said instrument is the corporate seal of said company; that the same was so affixed in pursuance of a resolution of the board of directors of said company, duly passed at a meeting of said board; and that by a like resolution so passed at the same meeting of said board, he signed the same instrument as President of said Company. All which is to me satisfactory evidence of said facts; and the instrument is authorized to be recorded.

GEO. GOULD, *a Justice of the Supreme Court
of the State of New York.*

Received for record March 10th, 1858, and recorded by me.

S. H. BLACKMER, *County Clerk.*

(Recorded in book 10, pp. 221, 2, 3, 4, 5.)

Received for record, April 27, 1860, and recorded by me.

S. H. BLACKMER, *County Clerk.*

(Recorded in book 10, p. 225.)

Whereas, by agreement heretofore made, the Southern Vermont Railroad Company did let, and the Troy and Boston Railroad Company did hire, the railroad of said Southern Vermont Railroad Company: and by said agreement the said Troy and Boston Railroad Company was, as part of the consideration of such letting, to pay the coupons of certain bonds of said Southern Vermont Railroad Company; (said bonds amounting to not more than one hundred and fifty thousand dollars of principal, and the coupons thereof to be paid semi-annually, for interest at the rate of six per cent. on said principal;) which bonds were to be payable in not less than twenty years from the 8th day of January, 1857: And whereas, by reason of delays in completing the arrangements for executing the written lease of said railroad, by and between said two railroad companies, the said lease was not executed prior to the 8th day of January, 1857, (as it was expected to be;) and when executed, was executed in separate parts, by each of said railroad companies; one of which parts is recorded in the office of the Clerk of Bennington County, (Vermont,) in book 10, on pages 221 to 225, and the other

of which parts is recorded in the same office, in the same book, on pages 226 to 231: And in the first recorded of said parts, said bonds are mentioned as being payable “in not less than twenty years from the first of May next”—(the said part bearing date November 21st, 1856, so that said bonds would thereby be payable not before the first day of May, 1877)—and the other of said parts bears date the 9th day of January, 1857, and in it said bonds are mentioned as being payable “in not less than twenty years from the 8th day of January *next*”—(so that said bonds would thereby be payable not before the 8th day of January, 1878.) And whereas the bonds for the payment of the coupons, whereof the said lease provides and was to provide, were duly made as by the original agreement, and were payable on the 8th day of January, 1877.

Now, therefore, it is mutually acknowledged and agreed, by and between the said two railroad companies, that the said bonds, as actually made and issued, are the bonds the coupons of which were intended to be provided for in and by the provisions of said lease; and that the provisions (in said parts of said lease contained) which relate to the bonds and coupons of said Southern Vermont Railroad Company do, and are to in all respects apply to the said bonds actually issued by said last named company. In testimony whereof the said Troy and Boston Railroad Company, have hereunto caused to be affixed its corporate seal, with the signatures of its president and secretary, this 27th day of April, A. D. 1860.

TROY AND BOSTON R. R. CO.

D. THS. VAIL, *Pt.*

JARED S. WEED, *Sec'y* [SEAL.]
of Troy and Boston Railroad Co.

In the presence of

HENRY RICHARDSON.

HENRY CARTWRIGHT.

In witness whereof, the Southern Vermont Railroad Company, by Abraham B. Gardner, its agent, duly authorized at a meeting of said company on the 27th day of April, A. D. 1860, has hereto subscribed its corporate name and affixed its corporate seal, this 27th day of April, A. D. 1860.

SOUTHERN VERMONT RAILROAD COMPANY,

By ABRAHAM B. GARDNER, *Agent.* [SEAL.]

Signed, sealed, and delivered, in presence of

NEWTON STONE.

SAMUEL H. BLACKMER.

STATE OF NEW YORK.

Rensselaer County, ss.

On this 27th day of April, 1860, before me personally appeared D. Thomas Vail, to me known, who being by me duly sworn, testified that he is the President of the Troy and Boston Railroad Company, and knows the corporate seal of said company; that the seal affixed to the instrument above as such seal is the seal of said company, and the same was affixed thereto in pursuance of a resolution of the board of directors of said company duly passed at a meeting of such board, and that he signed said instrument, as president of said company, under a like resolution similarly passed.

GEORGE GOULD, *a Justice of the Supreme Court of the State of New York.*

STATE OF VERMONT.

Bennington County, ss.

BENNINGTON, April 27, 1860.

Then personally appeared the said Abraham B. Gardner, agent as aforesaid, and who executed the written and foregoing instrument for and on behalf of the said Southern Vermont Railroad Company, and acknowledged the same to be the free act and deed of said company.

Before me, Samuel H. Blackmer, Justice of the Peace. Received for record, April 27, 1860, and recorded by me, S. H. Blackmer, County Clerk. Recorded in book 10, pages 234, 5, 6, and 7.

Deed of the Southern Vermont Railroad to the Troy and Greenfield Railroad Company.

Whereas, by divers Acts of the legislatures of the State of Massachusetts and Vermont, provision has been made for uniting and consolidating into one corporation the Troy and Greenfield Railroad Company, a corporation established under the laws of the State of Massachusetts, and the Southern Vermont Railroad Company, a corporation established under the laws of the State of Vermont, which consolidation has not been heretofore effected, and whereas, the legislature of the State of Massachusetts, by an Act passed on the fourth day of April, eighteen hundred and sixty, entitled "An Act in addition to an Act authorizing a loan of the State credit to enable the Troy and Greenfield Railroad Company to construct the Hoosac Tunnel," has authorized and required the Troy and Greenfield Railroad Company to purchase the entire road franchise, stock, bonds and other property of the Southern Vermont Railroad Company, together with the income, benefits, and rever-

sion of its lease to the Troy and Boston Railroad Company, upon the terms and for the purposes in said Act set forth, and has further by the said Act, provided the means for making such purchase, whereby the desired consolidation of said companies into one can be effected in a manner not only just and equitable to all parties interested in said companies, but calculated to secure the early completion and good management of the line of road from Troy to Boston, through the tunnel under Hoosac Mountain, and whereas, the legislature of the State of Vermont is not now in session, so that the legislation required by said Act on the part of that State cannot be immediately obtained, and whereas, the readiest and most satisfactory way of carrying into effect the requirements of said Act, appears to be the consummation of said purchase and sale by and between said companies, and subsequent ratification thereof by the legislature of the State of Vermont, now, therefore,

Know all men by these presents, that the Southern Vermont Railroad Company, a corporation established by an Act of the legislature of the State of Vermont, approved the thirteenth day of November, in the year eighteen hundred and forty-eight, entitled "An Act to incorporate the Southern Vermont Railroad Company," in consideration of two hundred thousand dollars to the Southern Vermont Railroad Company paid and to be paid by the Troy and Greenfield Railroad Company, a corporation established by an Act of the legislature of Massachusetts, approved the tenth day of May, in the year eighteen hundred and forty-eight, entitled "An Act to incorporate the Troy and Greenfield Railroad Company," in a manner as provided by said Act of the legislature of Massachusetts, passed the fourth day of April, in the year eighteen hundred and sixty, has granted, bargained, sold, transferred and assigned, and does by these presents grant, bargain, sell, transfer and assign unto the said Troy and Greenfield Railroad Company, its successors and assigns, the entire railroad of said grantor corporation extending from its junction with the Troy and Boston Railroad, at the State line of New York, through the town of Pownal, in the county of Bennington and State of Vermont, to its junction with the Troy and Greenfield Railroad at the State line of Massachusetts, and all the lands, depots, buildings, structures, and other property connected therewith or belonging thereto, and all the franchises, capital stock, bonds, leases, contracts, rights, privileges, and other property of said grantor corporation, including the lease made by said grantor corporation to the Troy and Boston Railroad Company, dated the twenty-first day of November, in the year one thousand eight hundred and fifty-six, one part of which, held by

the lessor corporation, is hereto annexed, and all the income, benefits and reversion thereof. Reserving however out of the above granted premises, until the confirmation of this sale and conveyance by the legislature of the State of Vermont, twenty shares of the capital stock of said grantor corporation of the par value of one hundred dollars each, which said twenty shares, however, shall upon said confirmation being obtained, pass to and be vested in said grantee corporation.

To have and to hold the above granted premises with the privileges and appurtenances to the same belonging, to the said Troy and Greenfield Railroad Company, its successors and assigns, to its and their sole use and behoof forever.

And the said grantor corporation hereby covenants to and with the said grantee corporation, that it will as soon as may be, procure from the legislature of the State of Vermont full confirmation of this sale and conveyance; that it will warrant and defend all the above granted premises to said grantee corporation and its assigns against the lawful claims and demands of all persons whatsoever, and that it will upon request of said grantee corporation execute and deliver to it or its assigns all further assurances of title which said grantee corporation may prescribe. And said grantor corporation doth hereby constitute and appoint the said grantee corporation its true, sufficient and irrevocable attorney, with full power of substitution in the name of said grantor corporation or in any and every other manner to enter upon, claim, receive and receipt for, possess, hold and enjoy for the sole use and benefit of said grantee corporation and its assigns, all the above granted premises, and to do and perform all acts and things in respect thereto which said grantor corporation, but for these presents, might do or perform, hereby ratifying and confirming all the same.

In witness, whereof, the said Southern Vermont Railroad Company has caused its corporate seal to be affixed, and its corporate name to be subscribed to these presents, by R. Carpenter, Jr., H. Cartwright, and H. Haupt, its agents, hereto duly authorized, this twenty-first day of April in the year eighteen hundred and sixty, at a meeting of its stockholders and directors.

SOUTHERN VERMONT RAILROAD COMPANY,

By R. CARPENTER, Jr.,

HENRY CARTWRIGHT, [SEAL.]

H. HAUPT, *Agents*.

Signed, sealed, and delivered, in the presence of

A. B. GARDNER.

ELIJAH BARBER.

STATE OF VERMONT.

Bennington County, ss.

April 21st, A. D. 1860.

Then personally appeared the aforesaid R. Carpenter, Jr., H. Cartwright, and H. Haupt, agents of the Southern Vermont Railroad Company, and acknowledged the foregoing instrument to be the free act and deed of the said Southern Vermont Railroad Company, and that the same was executed by them on its behalf and by its authority.

Before me,

A. B. GARDNER, *Justice of the Peace.*

TOWN CLERK'S OFFICE, POWNAL.

Received for record, April 21st, 1860, at 4 o'clock 20 minutes P. M., by me at my office, which is the only place for recording of deeds in and for the town of Pownal, and recorded in book 20, pages No. 408, 9, 10, and 411.

HARMON MYERS, *Town Clerk.**Mortgage of the Southern Vermont Railroad to the Commonwealth.*

Know all men by these Presents, That the Troy and Greenfield Railroad Company, a corporation established under the laws of the Commonwealth of Massachusetts, in consideration of two hundred thousand dollars to said corporation paid and to be paid by the Commonwealth of Massachusetts in the manner and for the purposes set forth in an Act of the legislature of said Commonwealth, passed April fourth, eighteen hundred and sixty, entitled "An Act in addition to an Act authorizing a loan of the State credit, to enable the Troy and Greenfield Railroad Company to construct the Hoosac Tunnel," and in consideration of and in compliance with the provisions of said Act, has granted, bargained, sold, transferred and assigned, and does by these presents grant, bargain, sell, transfer and assign unto the Commonwealth of Massachusetts and her assigns, the entire railroad of the Southern Vermont Railroad Company, extending from its junction with the Troy and Boston Railroad, at the State line of New York through the town of Pownal, in the County of Bennington, and State of Vermont, to its junction with the Troy and Greenfield Railroad at the State line of Massachusetts, and all the lands, depots, buildings, structures and other property connected with or belonging thereto, and all the franchises, capital stock, bonds, leases, contracts, rights and privileges and other property of said Southern Vermont Railroad Com-

pany, including the lease made by said Southern Vermont Railroad Company to the Troy and Boston Railroad Company, dated the twenty-first day of November, in the year eighteen hundred and fifty-six, one part of which held by the grantor corporation is hereto annexed, and all the income, benefits and reversion thereof, meaning and intending hereby to convey to said Commonwealth all the estate and property of every name and description conveyed or described in the deed of said Southern Vermont Railroad Company to the said Troy and Greenfield Railroad Company by its deed dated the twenty-first day of April, in the year eighteen hundred and sixty, hereto annexed, and made part hereof.

To have and to hold the above granted premises, with the privileges and appurtenances to the same belonging to the Commonwealth of Massachusetts and her assigns, to her and their sole use and behoof.

And the said grantor corporation hereby covenants with the Commonwealth of Massachusetts, that it will, as soon as may be, procure from the legislature of the State of Vermont full confirmation of the sale and conveyance made by the Southern Vermont Railroad Company, to it, by the deed annexed, and of this conveyance by itself to the said Commonwealth; that it will warrant and defend all the above granted premises to the said Commonwealth and its assigns, against the lawful claims and demands of all persons; and that it will, upon request of the Attorney-General execute and deliver to said Commonwealth, or her assigns, any and all further assurances of title which he may prescribe.

And the said Troy and Greenfield Railroad Company doth hereby constitute and appoint said Commonwealth, and her authorized agents, its true, sufficient and irrevocable attorney and attorneys, with full power of substitution in the name of the Southern Vermont Railroad Company, or of the Troy and Greenfield Railroad Company, or in any and every other manner, to enter upon, claim, receive and receipt for, possess, hold and enjoy for the sole use and benefit of said Commonwealth and her assigns all the above granted premises, and to do and perform all acts and things in respect thereto, which the said Southern Vermont Railroad Company but for its annexed deed, or the Troy and Greenfield Railroad Company but for this conveyance, might do or perform, hereby ratifying and confirming all of the same.

Provided, however, that if the Troy and Greenfield Railroad Company shall well and truly comply with, and perform all the requirements of an Act of said Commonwealth, passed the fifth day of April in the year eighteen hundred and fifty-four, entitled, "An

Act authorizing a loan of the State credit to enable the Troy and Greenfield Railroad Company to construct the Hoosac Tunnel," and of an Act in addition thereto, passed the twenty-sixth day of March in the year eighteen hundred and fifty-nine, and of an Act also in addition thereto, passed the fourth day of April in the year eighteen hundred and sixty, so far as the same are unrepealed, and of all future Acts which the said legislature may enact touching the same, and shall indemnify and save harmless the Commonwealth from all loss or inconvenience on account of the scrip or certificates of debt authorized to be issued by said Acts, whether the same have heretofore been or may hereafter be issued; and if said corporation shall well and truly pay the principal sum of said scrip or certificates which have been or may be delivered to its treasurer, punctually, when the same shall become due, or such part thereof as the sinking fund may be insufficient to pay, and the interest thereon semi-annually, as by law required, then the foregoing conveyance shall be void, otherwise of full force and virtue.

In witness whereof, the said Troy and Greenfield Railroad Company has caused its corporate seal to be affixed, and its corporate name to be subscribed, to these presents, by Henry L. Sabin, Harvey Arnold and Herman Haupt, its committee hereunto duly authorized, this twenty-first day of April, in the year eighteen hundred and sixty.

TROY AND GREENFIELD RAILROAD COMPANY,

By HENRY L. SABIN,

HARVEY ARNOLD, [SEAL.]

HERMAN HAUPT,

Committee.

Signed, sealed and delivered in presence of

S. HOSFORD.

HENRY CARTWRIGHT.

COMMONWEALTH OF MASSACHUSETTS.

Berkshire Co., ss. April 21st, A. D. 1860. Then personally appeared the aforesaid Henry L. Sabin, Harvey Arnold and Herman Haupt, a committee of the Troy and Greenfield Railroad Company, and acknowledged the foregoing instrument to be the free act and deed of the said Troy and Greenfield Railroad Company, and that the same was executed by them on its behalf and by its authority.

Before me,

STEPHEN HOSFORD, *Justice of the Peace.*

TOWN CLERK'S OFFICE, POWNAL. Received for record April 21st, 1860, at 4 o'clock 20 minutes, P. M., by me, at my office, which is the only place for recording of deeds in and for the town of Pownal, and recorded in book No. 20, pages 412, 13, 14 and 15.

HARMON MYERS, *Town Clerk.*

Commonwealth of Massachusetts. May 2, 1860. The accompanying transfer is satisfactory in frame, and in compliance with the provisions of the statute of 1860, chap. 202, sect. 8.

STEPHEN H. PHILLIPS, *Attorney-General.*

VERMONT ACTS.

AN ACT TO AUTHORIZE THE TROY AND GREENFIELD RAILROAD COMPANY TO PURCHASE AND HOLD THE FRANCHISE, RAILROAD AND PROPERTY OF THE SOUTHERN VERMONT RAILROAD COMPANY.

It is hereby enacted by the General Assembly of the State of Vermont, as follows:—

SECT. 1. Authority is granted to the Troy and Greenfield Railroad Company, a corporation established by the laws of the State of Massachusetts, to purchase, hold and mortgage to the State of Massachusetts, the franchise, railroad and property of the Southern Vermont Railroad Company, a corporation established by the laws of this State, according to the provisions and requirements of an act of the legislature of the State of Massachusetts, approved April 4, 1860, entitled "An Act in addition to an Act authorizing the loan of the State credit to the Troy and Greenfield Railroad Company, to construct the Hoosac Tunnel," and all sales, conveyances, transfers and mortgages heretofore made by the Southern Vermont Railroad Company, or by either of said companies to the State of Massachusetts, are hereby ratified and confirmed.

SECT. 2. The Troy and Greenfield Railroad Company, as such corporation as aforesaid, may hold, use and enjoy the franchise, railroad and property so purchased, subject to the provisions of the ninth, tenth, eleventh, twelfth, thirteenth, fourteenth, twenty-third, twenty-fifth, twenty-sixth, twenty-seventh, twenty-eighth and twenty-ninth sections of an act of the general assembly of this State, approved November 13, 1848, entitled "An Act to incorporate the Southern Vermont Railroad Company," all of which shall have force and apply to the Troy and Greenfield Railroad Company, so far as it respects its franchise, railroad and property situate within this State; and the directors of said company shall appoint an agent on whom process may be served, who shall reside in this State, and whose appointment shall be recorded in the office of the clerk of the town of Pownal in Bennington county in this State.

SECT. 3. All acts and parts of acts inconsistent with this act, are hereby repealed.

SECT. 4. This act shall take effect from its passage. [*Approved November 10, 1860.*]

Report of a Committee of the Executive Council on the conveyances of the Southern Vermont Railroad.

EXECUTIVE DEPARTMENT, BOSTON, May 3, 1860.

The Committee of the Council to whom was referred, (under the 8th section of chapter 202 of the laws of 1860,) the mortgage to the Commonwealth by the Troy and Greenfield Railroad Company, of the franchise and property of the Southern Vermont Railroad Company, and the lease of the same to the Troy and Boston Railroad Company, together with the accompanying papers as specified in a communication to His Excellency the Governor and the honorable Council, dated April 26, 1860, and signed by Wendell T. Davis and H. Haupt, a Committee appointed by the Troy and Greenfield Railroad Company for that purpose—which papers accompany this Report, and are marked A, B, C, D, E, F, G, H, I, J, K, L, M and N—have given the subject a careful consideration, and Report: That said mortgage and accompanying papers are correct, satisfactory, and according to the provisions of said chapter 202, section 8, of the laws of 1860; and that the said Troy and Greenfield Railroad Company have deposited in the State treasury (as appears by the accompanying receipt of the State Treasurer) four hundred and eighty shares of the capital stock of the said Southern Vermont Railroad Company, which is all the capital stock of said company, excepting twenty shares,—and the bonds of said Southern Vermont Railroad Company to the amount of one hundred and forty-nine thousand and four hundred dollars, being all the bonds issued by said company, excepting six hundred dollars; as provided in said chapter 202, section 8, of the laws of 1860.

The Committee also report that said papers are endorsed by the Attorney-General of the Commonwealth as “correct and according to the statute provisions.”

ELIPHALET TRASK,

J. M. CHURCHILL,

HUGH W. GREENE,

Committee.

COUNCIL CHAMBER, May 3d, 1860.

The foregoing Report is by the Governor and Council accepted.

OLIVER WARNER,

Secretary of the Commonwealth.

SECRETARY'S DEPARTMENT, May 4th, 1860.

The foregoing is a true copy of the original, on file in this Department.

OLIVER WARNER,

Secretary of the Commonwealth.

SOUTHERN VERMONT RAILROAD ACTS.

AN ACT TO INCORPORATE THE SOUTHERN VERMONT RAILROAD COMPANY.

It is hereby enacted by the General Assembly of the State of Vermont, as follows:—

SECT. 1. Such persons as shall hereafter become stockholders, are constituted a body corporate, by the name of the Southern Vermont Railroad Company, for the purpose, and with the right of building a railroad, with a single or double track, from some point on the southern line of the State, in the county of Bennington or Windham, to some point in the western line of the State, in the county of Bennington, to transport and carry persons and property on the same, by the power of steam or otherwise, and by that name may sue and be sued, may have a seal, and shall have all the rights incident to corporations.

SECT. 2. If the said corporation shall not within two years commence the construction of the road, and shall not within five years complete and put in operation said road, then said company shall be dissolved, and this act be void.

SECT. 3. The capital stock of said company shall be two hundred thousand dollars, which may be increased to an amount sufficient to complete said road, and furnish all necessary apparatus for conveyance, which shall be divided into shares of one hundred dollars each, and shall be deemed personal property, and transferable in such manner as such corporation shall, by their by-laws, direct.

SECT. 4. John M. Potter, B. E. Brownell, A. B. Gardner, John S. Robinson, Benjamin F. Morgan, J. N. Carpenter, James P. Godfrey, Heman Swift, Lyman Patchin, S. H. Blackmer, and Pierpoint Isham, shall be commissioners, whose duty it shall be, within one year, to open books for receiving subscriptions to the capital stock of said company, at some convenient place in Pownal and Bennington, and such other places as said commissioners shall direct; and thirty days' notice shall be given by said commissioners, of the time and place of opening said books, by publishing the same in some public newspaper, printed in the county of Bennington; and as soon as five hundred shares of said stock shall be subscribed, shall give notice in like manner for a meeting of the stockholders, at such time and place as they shall order, for the election of nine

directors; and such election shall then and there be made by such of the stockholders as shall be present, either in person or by proxy, each proprietor being entitled to as many votes as he holds shares; and the commissioners shall be inspectors of said election, and shall certify the names of those duly elected, and shall deliver over to said directors the subscription books and other papers; and said directors shall then proceed to elect from their number a president and vice-president, and so at all subsequent elections of directors; and the time and place of holding the first meeting of the directors shall be fixed by the commissioners; and a new election shall be made, annually, at such time and place as the directors shall appoint, giving twenty days' notice of the same, by publication in a newspaper printed in the county aforesaid, and in such other papers as they may deem proper—and said directors may cause such examinations and surveys of said road, or any part thereof, to be made as they shall deem necessary; and when said road or any part thereof shall be surveyed, the directors shall certify the same under their hands and seals, and cause certificates to be recorded in each town, through which such road is laid, of that portion of the road lying within said town; which road, so surveyed and certified, shall be deemed the line upon which said road is to be constructed as hereinafter mentioned; and the corporation may make such alterations from time to time, in the course of said road, as they shall deem expedient, causing a certificate of the same to be recorded in the office of the town clerk of the town in which such alteration is made, the expenses of such surveys, and all incidental expenses relating thereto, shall be paid by said corporation.

SECT. 5. The vice-president shall preside at all meetings of the directors, in case of the absence or resignation of the president, and may exercise such powers and functions as the corporation shall, by their by-laws, provide.

SECT. 6. If it should happen at any time that an election of directors should not be made on the day it ought to have been, pursuant to this act, said corporation shall not for that cause be dissolved, but the election may be held at any other time provided for by their by-laws.

SECT. 7. The directors, or such portion of them as their by-laws direct, shall form a board, who shall be competent to transact all the business of said corporation, and shall have power to make and prescribe by-laws and regulations for the proper management and disposition of the stock, property and effects of said corporation, the transfer of shares, conduct of their officers, election of directors, and all other matters appertaining to said corporation, and shall

have power to appoint a clerk and treasurer, who shall give bonds to said corporation, with sureties, to the satisfaction of the directors, in a sum not less than twenty thousand dollars, for the faithful discharge of his trust, and to establish such salaries for the officers of said corporation, as they deem proper; and said corporation are hereby authorized by their agents, surveyors, and engineers, to enter upon said route, designated as aforesaid, and it shall be lawful for said corporation to enter upon, and take possession of all such lands and real estate as is necessary for the construction and maintenance of their railroad, and the requisite accommodations appertaining thereto, and may enter upon any lands in the vicinity of said railroad, for the purpose of procuring earth, sand, gravel or stone, for the construction and repairs of said railroad; and may receive, hold and take, all voluntary grants and donations of real estate that shall be made to said corporation for the benefit of said company.

All lands thus entered upon and used by said corporation, which are not gifts or donations, shall be purchased by said corporation of the owner or owners of the same; and in case the parties disagree upon the price of said lands, and before making any portion of said road upon such lands, it shall be the duty of the judges of the county court, of the county in which such lands lie, to appoint three disinterested commissioners, who shall determine the damages which the owner or owners of said lands so entered upon, may have sustained, or shall be likely to sustain, by the occupation of the same; and upon the payment of such damages, with the expenses attending the appraisement, the said commissioners being allowed two dollars each, per day, while thus employed; or upon said corporation depositing in any bank, in any county through which said road passes, to the credit of the person or persons to whom an award may have been made, the amount of said damages, with the expenses aforesaid, the proper officers of said bank giving notice to such person or persons, by letter, of such deposit; then said corporation shall be deemed to be seized and possessed of such lands so appraised by said commissioners.

And it shall be the duty of said commissioners to give at least ten days' notice, of the time and place of such appraisement, to the owners or occupants of the lands to be appraised; and, after the appraisal, shall, as soon as may be, deliver to said corporation a written statement of the awards by them made, with a description of the lands appraised, which shall, within sixty days, be recorded in the office of the town clerk of the town in which said lands lie and in case any owner or owners of lands taken by said company,

shall be married women, infants, idiots, or insane, or shall reside without this State, in such case, said corporation shall cause the damages to be ascertained in the manner above prescribed, and shall pay the amount of said last mentioned damages to the owners respectively, whenever the same shall be lawfully demanded, with the interest, at the rate of six per cent. per annum, which amount and interest shall be a specific lien on the real estate of said corporation, and shall have a preference to any other demand against said corporation.

SECT. 8. Should such corporation, or the owner of any lands, feel themselves aggrieved by the decision of the commissioners aforesaid, either party may, within ninety days from the making said decision and notice thereof, or from the removal of the disabilities in the preceding section mentioned, or from the return of such non-resident, appeal to the county court in the county in which said lands or other property lie, and the decision of said court shall be final; and said court shall tax costs for or against either party, as they shall judge equitable.

SECT. 9. Said company may build and use a double or single track upon said road, as shall be determined by said company.

SECT. 10. Toll is granted for the benefit of said corporation upon all passengers and property which may be conveyed or transported upon said road, at such rate per mile as may be established, from time to time, by the directors: *provided*, the supreme court, at any stated session thereof, held in the county of Bennington, on application of ten freeholders in any town through which the said road passes, may alter or establish the rate of toll upon said road for a term of time not exceeding ten years, at any one time, and in such manner, that the corporation shall not receive less than twelve per cent. per annum, on the amount of capital stock, after deducting all the expenses of the corporation, after the corporation shall commence taking toll on said road.

SECT. 11. The directors of said corporation may erect toll-houses, establish gates, appoint toll-gatherers, and demand toll upon said road, when completed, or upon such parts thereof as shall, from time to time, be completed; and shall keep just and true books and accounts of all expenditures made in building and keeping in repair said railroad, and also of all the income arising from said road, which books shall, at all times, be open to the inspection of any committee of the legislature, or of the supreme court, and any such committee may examine the officers of said corporation, under oath, touching the receipts and expenditures of said corporation.

SECT. 12. Said corporation shall keep constantly exposed to view, at all places where they have toll-houses, or gates, and at all public places where they receive passengers or freight, a sign or handbill, with the rates of toll legibly written or printed thereon.

SECT. 13. If any person shall wilfully, maliciously or wantonly obstruct the passage of any carriage on said road, or in any way injure or destroy said road, or any part thereof, or anything belonging thereto, or any material or implement employed in the construction thereof, he, or any person or persons assisting, aiding, or abetting in such trespass, shall forfeit and pay to said corporation, for every such offence, such damages as shall be assessed before any court proper to try the same; and such offender or offenders shall be liable to indictment by the grand jury of the county within which such trespass shall have been committed, for any offence contrary to the above provisions, and on conviction thereof, before such county court, shall pay a fine, not exceeding one hundred dollars, and not less than twenty dollars, to the use of the State.

SECT. 14. If said railroad shall cross any private way, said corporation shall so construct the same as not to obstruct the safe and convenient use of said private way; and if said railroad shall not be so constructed, the party aggrieved may have an action on the case, in any court proper to try the same, and recover reasonable damages for such injury; and if said railroad shall cross any canal, highway, or turnpike, the same shall be so constructed as not to impede or obstruct the safe and convenient use of such canal, highway, or turnpike, and said corporation may raise or lower such turnpike, highway, or private way, so that said railroad, if necessary, may pass over or under the same; and if said corporation shall raise or lower any such turnpike, highway, or private way, and shall not so raise or lower the same as to be satisfactory to the proprietors of said turnpike, or to the selectmen of the town in which said highway or private way is situated, said proprietors or selectmen, may require, in writing, of said corporation, such alteration or amendment as they shall think necessary; and if the required amendment or alteration be reasonable and proper, and said corporation shall unnecessarily neglect to make the same, such proprietors or selectmen may make such alteration or amendment, and may prosecute to final judgment and execution in any court proper to try the same, an action of the case against said corporation, and shall therein recover a reasonable indemnity in damages, for all expenses occasioned by making such alteration, with costs of suit; and if said railroad shall intersect or cross any stream of water or water-course, said corporation may construct the same across a

stream or water-course, provided they restore said stream or water-course to its former state, or in a sufficient manner not to impair its usefulness; and the said company shall constantly maintain in good repair all bridges, with their abutments, and embankments, which they may construct for the purpose of conducting said road over any turnpike, private way, or highway, or for conducting such turnpike, private way, or highway, over said railroad, and in default thereof, shall be liable to an action on the case, to pay all damages to any party aggrieved; and said corporation shall build and maintain a sufficient fence upon each side of their railroad through the whole route thereof.

Provided, that nothing in this act contained shall be so construed as to prevent the crossing of said railroad, with teams or otherwise, in a manner not calculated to injure the same.

SECT. 15. The legislature may at any time, after the expiration of fifty years from the opening for use of the road, and not before, purchase of the corporation, the railroad and all the property, rights and privileges thereof, by paying therefor the amount expended in making the same. And if, at the time of purchase, the corporation shall not have received an income equal to ten per cent. per annum, on the original costs over and above the charges and expenses relating thereto, the legislature shall pay the corporation such additional sum as, together with the tolls and profits of every kind received from the road, will be equal to ten per cent. per annum on the cost of the road, from the date of the payment thereof by the stockholders of the corporation to the time of such purchase.

SECT. 16. The directors may require payment of the sums subscribed to the capital stock, at such times, and in such proportions, and on such conditions as they shall deem best, under the penalty of forfeiture of all previous payments thereon; and shall give notice of the payments required, and the time and place where the same are to be paid, at least thirty days previous thereto in a newspaper published in said county of Bennington.

SECT. 17. The commissioners may, at the time of subscription of any person for the capital stock of said corporation, require payment by the person subscribing, of such sums towards each share, as they may deem best, which shall not be less than five per centum of the capital stock; and unless the sum shall be paid, the subscription shall be void, and in case a greater amount of capital stock shall be subscribed than the sum of two hundred thousand dollars, the commissioners shall distribute the stock in such manner as they shall deem equitable and just.

SECT. 18. The office of the clerk of said corporation shall be kept within this State.

SECT. 19. The persons who shall become stockholders of any railroad company which has been, or may hereafter be, created by the Commonwealth of Massachusetts, or by the State of New York, and whose road shall connect with the road of this corporation at the south or west line of this State, shall be stockholders of this corporation, together with such persons as shall be stockholders of this corporation, and when the stockholders shall have assented thereto, the said corporations shall become united in one corporation, by the name of the Southern Vermont, Massachusetts, and New York Railroad Company, with a capital not exceeding the amount of the joint capital of said corporations; and all the tolls, franchises, rights, powers, privileges and property, granted or to be granted, acquired or to be acquired, under the authority of the State of Massachusetts, New York, or of this State, shall be held and enjoyed by all the stockholders, in proportion to the number of shares in either or all of said corporations.

SECT. 20. After the said union shall be perfected, the said stockholders shall hold their meetings, make their by-laws, appoint their officers, and transact all their business as one corporation: *provided*, that one or more of the officers of said corporation shall be resident in this State, and one or more of them in the Commonwealth of Massachusetts, and one or more of them in the State of New York, on whom process against said corporation may be legally served in either State; and said corporation shall be held to answer, within jurisdiction where service shall be made, and the process is returnable.

SECT. 21. The share or shares of any stockholder in said united corporation shall be liable to attachment, and to be taken on execution, in the State where such stockholder shall reside at the time of the service of such process; and if such stockholder shall not reside in either State, then the same shall be so liable in either State, and an attested copy of such writ or execution, and of the returns of the officers thereon, shall, at the time of such service, be left with the clerk or a director of said corporation, or at his usual place of abode, by the officer making the service.

SECT. 22. The said united corporation shall so make out and keep an account of the expenditures on said road, from its commencement to its completion, as clearly to exhibit what portion thereof belongs to that part of said road situated in Vermont, and what portion to that part in Massachusetts, and what portion to that part in New York, and three commissioners shall be appointed,

one by the governor of each State, to hold their offices for the term of five years, and to be reasonably compensated for their services by said corporation, who shall ascertain what proportion of expenditures on said road, and of the other expenditures attending its construction, maintenance and use; also, what proportion of the receipts and profits of said railroad shall properly appertain and belong to the portions of said road in each State, respectively, and shall annually make report thereof to the legislature of this State; the books of said united corporation shall, at all times, be open to the inspection of any committee of the legislature, or of the supreme court of this State; and any such committee may examine any officer of said corporation, under oath, relative to the receipts and expenditures of said corporation.

SECT. 23. The said corporation, so far as their road shall be situated in Vermont, shall be subject to the general laws of this State, to the same extent as if their road was wholly therein.

SECT. 24. The twentieth, twenty-first, twenty-second and twenty-third sections of this act shall not take effect until similar provisions shall have been enacted by each of the States of Massachusetts and New York, nor until the provisions so enacted in each State shall have been accepted by the stockholders of said corporations, at meetings duly called for that purpose; at which meeting they may ratify and confirm all or any of their former doings, and adopt them as the acts and doings of said united corporation.

SECT. 25. This act shall be taken and deemed a public act, and shall be construed favorably and beneficially for all the purposes for which the same is enacted.

SECT. 26. The directors of said Southern Vermont Railroad Company shall, annually, on or before the third Thursday of October, make a report to the legislature of their proceedings, receipts and expenditures.

SECT. 27. The corporations hereby established shall be required to transport upon their respective railroads, by their regular trips, the mails of the United States, and in case of any disagreement between the said corporations and the agents of the general government, touching the compensation for the same, it shall be the duty of the supreme court, on application of either of the parties, to establish and define the rates of compensation; which rates shall be binding upon the parties, until altered by said court upon similar application.

SECT. 28. And said corporation, after they shall commence the receiving of toll, shall be bound, at all times, to have said road in good repair, and a sufficient number of suitable carriages, and

vehicles for the transportation of persons and articles, and be obliged to receive, at all proper times and places, and convey the same, when the appropriate tolls therefor shall be paid or tendered; and a lien is hereby created on all articles transported, for the tolls due for the transportation thereof.

SECT. 29. The legislature of this State may authorize any company to enter with another railroad at any point of the road hereby granted, paying for the right to use of the same, or any part thereof, such rate of toll as the legislature may hereafter prescribe, and complying with such rules and regulations as may be established by the company hereby incorporated. [*Approved November 13, 1848.*]

[From Vermont Laws of 1849.]

AN ACT TO EXTEND THE CHARTER OF THE SOUTHERN VERMONT RAILROAD COMPANY.

“An Act entitled ‘An Act to incorporate the Southern Vermont Railroad Company,’ approved Nov. 13, 1848, is hereby extended and continued in force one year from the time specified in said Act, for all purposes whatsoever; so that the said corporation shall have the same rights and privileges, and the Act of incorporation shall have the same effect as it would have if passed at the present session of the legislature.”

[From Vermont Laws of 1850.]

AN ACT IN RELATION TO THE SOUTHERN VERMONT RAILROAD COMPANY.

SECT. 1. John M. Potter, B. E. Brownell, A. B. Gardner, Green Brimmer, Benjamin F. Morgan, Elijah Barber and Orrin Bates, shall be a Board of Commissioners to perform the duties mentioned in “An Act to incorporate the Southern Vermont Railroad Company,” approved Nov. 13, A. D. 1848.

SECT. 2. The commissioners named in the preceding section, or a majority of them, may call a meeting of the stockholders for the purpose of choosing directors of said company, as provided in the Act of incorporation of said company, whenever they shall have obtained subscriptions to the capital stock to the amount of twenty thousand dollars.

SECT. 3. The Act incorporating said company is hereby extended and continued in force five years from the time specified in said Act of incorporation, for all purposes whatsoever.

[From Vermont Laws of 1854.]

AN ACT IN RELATION TO THE SOUTHERN VERMONT RAILROAD COMPANY.

SECT. 1. The Act incorporating said company is hereby extended and continued in force until the thirteenth day of November, 1860, for all purposes whatsoever. [*Approved Nov. 13, 1854.*]

CONTRACT.

Whereas, For many years great efforts have been made by the Troy and Greenfield Railroad Company to finish their railroad and construct the Hoosac Tunnel, which, notwithstanding the aid granted to them by the Commonwealth of Massachusetts, they have found themselves wholly unable to accomplish, the means and credit of the Company having become exhausted, and further progress having stopped nearly two years ago, with no part of the road east of the tunnel opened for use, and the tunnel but little more than commenced; and,

Whereas, It is of the utmost importance to the rest of the railroads forming the line from Boston via Fitchburg and Greenfield to Troy, that the said Troy and Greenfield Railroad and Hoosac Tunnel should be completed, by which they may become part of a short through line to the West; and,

Whereas, The cost of constructing the said Hoosac Tunnel will be very large, and to a great extent uncertain in amount, and, at the least, wholly disproportionate to its revenue-earning value when considered as a piece of railroad of only its real length, while it will be of such vast benefit to the said whole line of railroads from Boston to Troy, that its construction is warranted as a commercial undertaking;

Nevertheless, the railroads so interested in and desirous of its construction, and to receive such large benefits therefrom, are not in a position to undertake it, or to render adequate aid to the Troy and Greenfield Railroad, to enable that Company to construct it, but in lieu thereof are willing to pay such just proportion of their earnings from business which may pass through said tunnel, or over said road, as shall be an equitable return for the benefits received.

Now, therefore, the Vermont and Massachusetts Railroad Company, and the Fitchburg Railroad Company, corporations created by the laws of Massachusetts, and the Troy and Boston Railroad Company, a corporation created by the laws of New York, in consideration, that the Commonwealth of Massachusetts shall construct, or complete, or cause to be constructed or completed, the said Troy and Greenfield Railroad and Hoosac Tunnel, hereby severally, and not jointly, agree and bind themselves and their assigns to the Commonwealth of Massachusetts, to pay to the said Commonwealth certain sums of money, as follows:—

Each of said companies hereby agrees to pay to said Commonwealth twenty (20) per cent., or one-fifth of all its gross earnings, upon such passenger and freight business as shall pass upon or over any part or the whole of the said Troy and Greenfield Railroad.

For example: If either of said companies shall transport upon their railroad a ton of freight, and receive as their gross earnings for the same the sum of one dollar and fifty cents, and said freight shall pass over said Troy and Greenfield Railroad, or any part thereof, either before or after such transportation, then this said Company shall pay to said Commonwealth the sum of thirty (30) cents, and in the same proportion for earnings from passengers, or for a greater or less amount of earnings from passengers or freight which passes over any part of said Troy and Greenfield Railroad.

Provided, that if and whenever the payment of the said twenty (20) per cent., together with any similar or other payments which may have been actually received from any and all other sources, on account of earnings, shall make the net earnings upon the cost of the said Troy and Greenfield Railroad and Hoosac Tunnel, and the equipment thereof, more than six (6) per cent. in any year, or the gross earnings more than thirteen (13) per cent. for any year, then and in that case the said twenty per cent. may be reduced, for the time being, to such a less per cent. as, together with any similar or other payments which may have been actually received from any and all other sources on account of earnings, shall make the said net earnings six (6) per cent., or the gross earnings thirteen (13) per cent. on the cost of the said Troy and Greenfield Railroad and Hoosac Tunnel, and the equipments thereof.

Provided, that whenever the earnings of the said Troy and Greenfield Railroad shall, without the payments therein provided for from the respective companies, amount for four (4) consecutive years to not less than six (6) per cent. net, or thirteen (13) per cent. gross, in each separate year, upon the cost of constructing the said Troy and Greenfield Railroad and Hoosac Tunnel, and the equipments thereof, then the payments herein provided for shall forever cease.

So far as this agreement is concerned, the cost of the said Troy and Greenfield Railroad and Hoosac Tunnel, and equipments thereof, shall be estimated to be, on the first day of January, A. D. 1863, the sum of nine hundred and sixty-eight thousand eight hundred and sixty-two dollars (\$968,862), to which shall be added the cost of their completion, as it shall be from time to time expended; and there shall also be added to the cost of construction the interest, at the rate of five (5) per cent., as it shall from time to time be paid on the bonds, which may be issued by the Commonwealth to raise money to pay for construction or interest; and upon such money as may not be raised by the issue of bonds, the interest at the same rate of five (5) per cent. shall be charged into the cost, on the first day of January and July in each year.

Provided, that no interest shall be charged into the cost of the works after eight years from the date hereof.

Provided, that all sums of money received as profits from operating or working a part of the said Troy and Greenfield Railroad, and for rents of the same before business shall commence to pass through the said tunnel, shall be deducted from the cost, as the same may from time to time be received.

And should it so happen after business shall have begun to pass through said tunnel, that the net earnings, over and above all expenses, together with the payments which may be received under the provisions of this contract, amount, in any one year, to less than five (5) per cent. net, or eleven (11) per cent. gross, upon the cost of the said Troy and Greenfield Railroad and Hoosac Tunnel, together with the equipments thereof, then and in any such case the deficit or amount which said net earnings and payments are below five (5) per cent. net, or eleven (11) per cent. gross, shall be added to the said cost, and the cost so increased shall be then reckoned, so far as this agreement is concerned, as the cost of the said Troy and Greenfield Railroad and Hoosac Tunnel, together with equipments thereof.

Settlements of accounts, under this provision, shall be for years ending December 31st, and for the first settlement, which may be for a fraction of a year, the interest shall be charged at the same pro rata rate for the said fraction of a year.

It is understood, that for such business as originates upon the Troy and Greenfield Railroad at or west of North Adams, and passes westward over any part of the Southern Vermont or Troy and Boston Railroads, and for such business as comes from the Troy and Boston or Southern Vermont Railroads and does not pass upon the Troy and Greenfield Railroad any further eastward than to North Adams, the Troy and Boston Railroad Company shall not, by reason of this contract, be required to make any contribution to the Commonwealth of Massachusetts.

It is hereby agreed, by the said several corporations, that they will pay and receive, as their respective proportions of the gross earnings on any freight or passengers which pass over the Troy and Greenfield Railroad, or any part thereof, and over any part or the whole of their several railroads, their pro rata proportion on each passenger or parcel of freight, which shall be computed and divided according to the distance it may have been carried upon the line between Boston and Troy; and from the gross earnings, so ascertained, the twenty (20) or other per cent. aforesaid is to come and be paid to the said Commonwealth, except as herein before provided in case of Troy and Boston Railroad Company.

The payment of the said twenty (20) or other per cent. to com-

mence when business begins to pass through the tunnel, though the said tunnel, or road and equipments, may not have been fully completed.

Such payments to be made monthly, as soon as practicable after the close of each month, and in any event before the close of the next succeeding month from the one for which the payment is due; and the books of said companies, in which are kept the earnings accounts, to be subject to the inspection, at any time, of a proper officer of the Commonwealth.

It is hereby agreed that, in the event of the Troy and Greenfield Railroad Company, or any other party, redeeming the said Troy and Greenfield Railroad and Hoosac Tunnel, and equipments, from the claims of the Commonwealth, the Commonwealth may, or may not, at its election, transfer to the party which should redeem, all its rights under this instrument, or continue to hold the same for its own benefit.

And the said Troy and Boston Railroad Company agrees that, for the purposes of this contract, the entire distance from the State line of Massachusetts to the city of Troy shall be deemed and treated a part of its road, although a portion thereof is leased by it from another corporation.

In witness whereof, the parties have hereunto affixed their hands and seals. The said Fitchburg Railroad Company, this 23d day of February, A. D. 1863, by their President, duly authorized therefor; and the said Vermont and Massachusetts Railroad Company, this twentieth (20th) day of February, A. D. 1863, by their President, duly authorized therefor; and the said Troy and Boston Railroad Company, this 18th day of February, A. D. 1863, by their President, duly authorized therefor.

TROY & BOSTON R. R. COMPANY,

By D. THOS. VAIL, *President*.

In presence of

D. W. MOSELY, as to signature

D. THOS. VAIL, *President*.

[SEAL.]

THE FITCHBURG RAILROAD COMPANY,

By JNO. J. SWIFT, *President*.

Witness the signature of

JOHN J. SWIFT, *President*,

A. CHAPMAN.

[SEAL.]

VERMONT & MASSACHUSETTS R. R. CO.,

By ROBERT HALE, *President*.

B. D. LOCKE, witness to signature of

ROBERT HALE, *President*.

[SEAL.]

To His Excellency the Governor and the Honorable Council.

The undersigned, to whom were referred the several proposals for constructing the Hoosac Tunnel for the purpose of computing the amount of the respective bids, report the annexed schedule showing such amounts respectively as ascertained by the engineers.

ALVAH CROCKER,
TAPPAN WENTWORTH,
S. W. BOWERMAN,
Commissioners.

BENJN D. FROST,
Superintending Engineer.

BENJN H. LATROBE,
Consulting Engineer.

Boston, September 5, 1868.

Aggregate Amounts of the several bids for the completion of the Hoosac Tunnel.

1. Carpenter, Odiorne & Gardner,	. . .	\$4,027,780 00
2. Wren, Brother & Co.,	. . .	4,437,886 00
3. Francis and Walter Shanly,	. . .	4,623,069 00
4. Jacob Humbird & Son,	. . .	4,690,183 00
5. Clark, Lyon, Hayden, Byron and Malone,	. . .	4,690,650 00
6. Bradbury & Duff,	. . .	4,800,000 00
7. Stanton & Doane,	. . .	4,881,766 00
8. H. Haupt,	. . .	5,000,000 00
9. Thomas Rutter,	. . .	5,302,006 00
10. L. Hitchcock & Co.,	. . .	5,342,357 00
11. A. G. Brown, C. W. Wentz & I. Brooks,	. . .	5,371,142 00
12. S. C. Walker & Co.,	. . .	5,378,354 00

The above parties have bid for the entire work.

The following have bid for it only in part:—

13. I. I. Dull, East End,	. . .	\$1,195,800 00
I. I. Dull, West Shaft,	. . .	1,656,127 00
14. McMahon & Kelly, East End,	. . .	1,261,000 00
15. B. H. Farren, West Shaft, in part.		

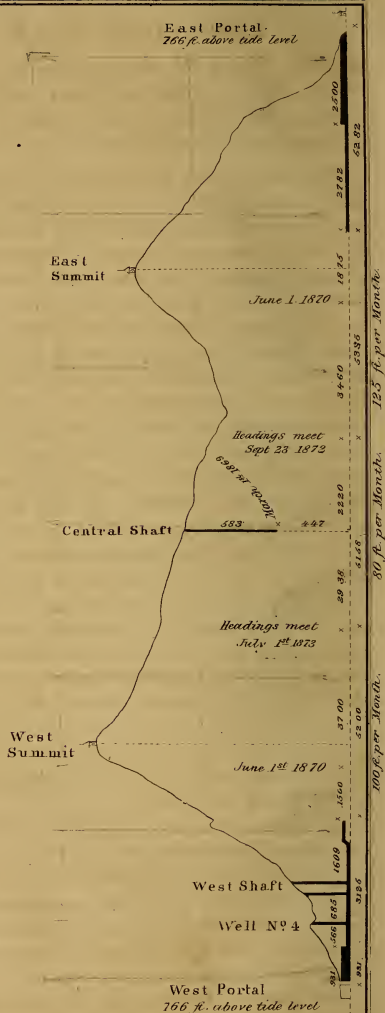
The following shows several combinations of bids for the separate sections of the work, which may be made :—

I.	Wren, Brother & Co., East End, . . .	\$1,119,750 00
	Carpenter, Odiorne & Gardner, Central Shaft, . . .	1,106,546 00
	I. I. Dull, West Shaft,	1,656,127 00
		<hr/>
		\$3,882,423 00
II.	Wren, Brother & Co., East End, . . .	\$1,119,750 00
	Carpenter & Co., Central Shaft, . . .	1,106,546 00
	Carpenter & Co., West Shaft, . . .	1,726,734 00
		<hr/>
		\$3,953,030 00
III.	Wren, Brother & Co., East End, . . .	\$1,119,750 00
	Clark, Lyon & Co., Central Shaft, . . .	1,381,380 00
	I. I. Dull, West End,	1,656,127 00
		<hr/>
		\$4,157,257 00
IV.	Carpenter & Co., East End,	\$1,194,500 00
	Clark, Lyon & Co., Central Shaft, . . .	1,381,380 00
	Francis Shanly & Bro., West End, . . .	1,715,519 00
		<hr/>
		\$4,291,399 00
V.	Jacob Humbird & Son, East End, . . .	\$1,226,000 00
	Clark, Lyon & Co., Central Shaft, . . .	1,381,380 00
	F. Shanly & Bro., West End,	1,715,519 00
		<hr/>
		\$4,322,899 00
VI.	McMahon & Kelly, East End,	\$1,261,000 00
	F. Shanly & Bro., Central Shaft, . . .	1,510,050 00
	F. Shanly & Bro., West Shaft,	1,715,519 00
		<hr/>
		\$4,486,569 00

Other combinations may also be made, should the parties be willing to enter into the arrangement, the above being presented only to show how the aggregate cost of the work may be affected by contracting for it with more than one party.

PROFILE OF HOOSAC MOUNTAIN.

Hor.^l Scale 4000 feet to 1 inch.
Ver.^l " 1000 " " "



MEMORANDUM OF AN AGREEMENT

Made at Boston on the twenty-fourth day of December, A. D. 1868, between WALTER SHANLY, of Montreal, and FRANCIS SHANLY, of Toronto, Canada, parties of the first part, and the COMMONWEALTH OF MASSACHUSETTS, party of the second part.

The parties of the first part hereby covenant and agree with the said Commonwealth to do and perform all the work necessary to complete the Hoosac Tunnel, with its Central Shaft, (being a portion of the Troy and Greenfield Railroad,) in accordance with the schedule hereunto appended, and furnish all materials, and lay down and complete through the whole length of the tunnel one railroad track, and after the completion of the tunnel and railroad track to remove from the tunnel all materials and other things, so as to leave the tunnel and railroad track in complete order, ready for use, and to the satisfaction of the governor and council of the Commonwealth; the whole to be done by the 1st day of March, A. D. 1874, and for the sum of four million five hundred and ninety-four thousand two hundred and sixty-eight dollars, (\$4,594,268,) to be paid, together with any interest accruing under this contract, by the Commonwealth to the parties of the first part, their heirs, executors, administrators or assigns, in United States Treasury notes, or other current funds, as hereinafter provided.

The size and general description of the work; the estimated amount of the same; the regulations governing the manner of its performance; the rates of progress required in its prosecution; and various general and particular stipulations and provisions affecting and binding both parties hereto, are set forth in the schedule hereunto appended, which constitutes a part of this agreement. But no errors in the estimates of the work to be done and materials to be furnished under this contract, shall affect the contract price to be paid for the whole work.

The parties of the first part will provide suitable and sufficient materials and machinery, and a sufficient and competent working force, and enter upon the prosecution of the work as soon as possible after the execution of this agreement, and will keep on hand and in operation at all times every means necessary to an expeditious and thorough fulfilment of this agreement on their part, according to its true intent and meaning.

And whereas, in consequence of the stopping of the work at the several points of operation, and for other reasons, the parties of the first part may not be able at the commencement to make the rate

of progress prescribed in the schedule hereunto appended, it is agreed that the governor and council may fix the time from and after which such rate of progress shall be made, and give notice thereof to the parties of the first part; which time, however, shall not be earlier than the 1st day of May next.

And whereas that portion of the tunnel which lies between the west and central shafts is expected to require a longer time for its construction than the other portions thereof, and difficulties now unexpected may arise, making it impossible to preserve the said prescribed rate of progress in other portions of the tunnel, it is agreed that in case of necessity the governor and council may by formal vote determine what extension of time shall be allowed; provided, however, that in no case shall the final completion of the whole work be delayed more than six months after the 1st day of March, A. D. 1874.

And if, after a full and fair opportunity has been had by the parties of the first part, the rates of progress prescribed by the schedule hereunto appended have not been made, and it shall plainly appear to the governor and council that the parties of the first part are and will be unable to make such rates of progress, on the average, the governor and council, after giving to the parties of the first part three months' notice in writing of their intention to do so, may, if their default continues, put an end to this contract, and resume possession of the work, and of all the shops, dwelling-houses, buildings, machinery, tools, and all the property whatsoever, belonging to the Commonwealth, which may have been delivered to the parties of the first part for use under this agreement.

The engineer or engineers of the Commonwealth shall give the lines and grades of the tunnel, and the lines of the central shaft, and be responsible therefor.

And for the purpose of determining the amount earned by the parties of the first part, from time to time, as the work proceeds, and for no other purpose, the following list of prices shall be taken as a basis of computation.

EAST END SECTION.

- 1st. For tunnel enlargement, per cubic yard, *sixteen dollars.*
- 2d. For heading enlargement, per cubic yard, *nine dollars.*
- 3d. For extension of full size tunnel, per cubic yard, *eleven dollars.*
- 4th. For excavation and construction of central drain, with air and water pipes complete, per linear foot of tunnel, *thirteen dollars.*
- 5th. For furnishing and laying one track complete, per mile, *fourteen thousand dollars.*

CENTRAL SECTION.

1st. For constructing fire-proof floor over shaft with self-closing iron hatches, *two thousand dollars.*

2d. For repair and completion of timbering to present depth of shaft, per foot in depth, *ten dollars.*

3d. For sinking shaft, per foot in depth, *three hundred and ninety-five dollars.*

4th. For two ten-inch iron pipes, set in place, per foot in depth of shaft, *six dollars.*

5th. For sinking sump below floor of tunnel, per foot in depth, *three hundred and ninety-five dollars.*

6th. For excavating full size section of tunnel, per cubic yard, *fourteen dollars.*

7th. For excavation and construction of central drain, with air and water pipes complete, per linear foot of tunnel, *thirteen dollars.*

8th. For furnishing and laying one track complete, per mile, *fourteen thousand dollars.*

WEST END SECTION.

1st. For heading enlargement, per cubic yard, *nine $\frac{7.5}{10}$ dollars.*

2d. For extending full size tunnel east, per cubic yard, *twelve dollars.*

3d. For arching part of tunnel with bricks, per M of bricks laid, *twenty-two dollars.*

4th. For excavating and constructing central drain and laying pipes for supply of air for power and ventilation and water, per linear foot of tunnel, *thirteen dollars.*

5th. For excavating central drain only, per linear foot of tunnel, *four $\frac{3.5}{10}$ dollars.*

6th. For constructing central drain west of west shaft, per linear foot, *three dollars.*

7th. For excavating for and constructing fifty linear feet of stone arch and filling over the same, *twenty-three thousand dollars.*

8th. For excavating for and constructing façade to the tunnel and filling around the same, *twenty-six thousand dollars.*

9th. For clearing out and timbering the Haupt tunnel and maintaining the same, *eight thousand five hundred dollars.*

10th. For furnishing and laying one track complete, per mile, *fourteen thousand dollars.*

And the engineer or engineers of the Commonwealth shall make a monthly measurement and computation of the amount of work done by the parties of the first part, which measurement and computation shall be conclusive upon the parties of the first part; and said engineer or engineers shall each month deliver a certificate in

writing, with a statement of the amount in money which has been earned accordingly, to the governor and council.

And whereas it is provided by the statute of 1868, chap. 333, that this contract shall contain satisfactory guarantees for the completion of the whole work herein contracted for, with limitations as to time and cost therein specified; and it is also provided by the statute of 1868, chap. 350, that this contract shall provide for payments by instalments, as the work progresses, in such manner that not less than twenty per centum of each amount due shall be reserved for a final payment on the completion of the same: Now, therefore, it is agreed that no sum whatever shall be demanded by or paid to the parties of the first part, under and in pursuance of this contract, until after they shall have earned, according to the certificates of the engineer or engineers, as above provided, approved by the governor and council, the full sum of five hundred thousand dollars; but twenty per cent. of each amount so certified by the engineer or engineers shall be reserved for the final payment on the completion of the whole work; and, for eighty per cent. of each amount so certified, certificates of the Commonwealth, under direction of the governor and council, and in form to be determined by the attorney-general, and approved by the governor and council, shall be issued to the parties of the first part, in sums of twenty thousand dollars each, setting forth the facts, bearing interest at the rate of five per cent. per annum from the time of issuing the same until the time of their redemption, and they shall be paid in Boston from time to time, in the order of their issue, as often as it shall appear by the further certificates of the engineer or engineers, approved by the governor and council, that the parties of the first part have earned so much, that, after reserving twenty per cent. thereof, the Commonwealth will still retain, in all, the full sum of five hundred thousand dollars which is covered by said certificates of the engineer or engineers—it being the intention of the parties hereto that the Commonwealth shall make no payment which will at any time reduce its security from the reserved fund of twenty per cent. and from its guarantee fund aforesaid, below the sum of five hundred thousand dollars. And the Commonwealth shall, until the completion of the contract, reserve twenty per cent. of each amount due for work done, according to the certificates of the engineer or engineers, for a final payment, without any addition for interest, on the completion of the whole work herein contracted for, and its acceptance by the governor and council; and, subject to the above reservations and provisions, the Commonwealth shall pay to the parties of the first part, at Boston, on or before the fif-

teenth day of each month following the performance of the work, eighty per cent. of the amount of money earned by them, as ascertained and shown by the certificates of the engineer or engineers; and upon the final completion of the whole work herein contracted for, and its acceptance by the governor and council, and upon the surrender by the parties of the first part to the Commonwealth of all real and personal property of the Commonwealth which the Commonwealth will then be entitled to receive from them, under the terms of this contract, and in reasonable and proper condition and manner, (reasonable use and wearing thereof, and loss or damage by fire or other unavoidable casualty excepted,) and upon the adjustment of all questions growing out of this contract, and the execution and delivery by the parties of the first part of a release of all claims and demands upon the Commonwealth growing out of this contract, then the Commonwealth will pay to the parties of the first part such further sum as may be necessary to make the full amount of four million five hundred and ninety-four thousand two hundred and sixty-eight dollars; provided that no more than \$3,594,268 shall be paid until the final completion of said work.

In witness whereof the said parties of the first part have hereunto set their hands and seals, and the governor of the Commonwealth and the council have also subscribed these presents and caused the seal of the Commonwealth to be hereunto affixed, on the day and year first above mentioned.

[STAMP.]

W. SHANLY. [SEAL.]

F. SHANLY, [SEAL.]

By his attorney, W. SHANLY.

[SEAL.]

ALEXANDER H. BULLOCK,
Governor.

WILLIAM CLAFLIN,
Lt. Governor.

THOS. TALBOT,
JOHN S. BRAYTON,
CHAS. ADAMS, JR.,
HORATIO G. KNIGHT,
CHAS. ENDICOTT,
PETER HARVEY,
R. G. USHER,
A. K. P. WELCH,

Executive Councillors.

SCHEDULE.

DIMENSIONS OF THE TUNNEL.

In rock, without arch, 24 feet wide in the clear; 20 feet high in the clear.

Where arching is required, 26 feet wide in the clear; $21\frac{1}{2}$ feet high above the rail when laid down.

A central drain to be constructed as required, with dimensions inside of masonry of not less than 2 feet square.

THE WORK REQUIRED TO BE DONE AT THE HOOSAC TUNNEL, UPON THE TROY AND GREENFIELD RAILROAD.

I.—EAST END OF TUNNEL.

The work already done consists of a tunnel extending into the mountain from the east portal about 2,500 feet, a portion of which has been enlarged to the full height of 20 feet and the width of 24 feet, as proposed, and of a heading about 2,782 feet long, of which 1,700 feet has an average section of about 16 by 8 feet, and the remaining 1,082 feet a section of about 24 by 8 feet, making the distance penetrated from the east portal, 5,282 feet.

The Work to be done is

1st. Enlargement of tunnel to full size of tunnel section required. Estimated amount, 4,500 cubic yards.

2d. Enlargement of heading to full size of tunnel section required. Estimated amount, 28,000 cubic yards.

3d. Extension of full size section of tunnel westward to meet workings to be brought eastward from central shaft. Estimated length, 5,300 feet, making 85,100 cubic yards.

4th. Excavation below floor of tunnel, and construction of a central drain, as exhibited on the sectional drawing in engineer's office in North Adams, a copy of which is annexed hereto. Estimated length, 5,600 feet.

5th. Provision and laying of the several permanent pipes in trench, as shown in drawing above described, for power, ventilation, and water supply, through a length of tunnel estimated to be 5,600 feet.

6th. Laying one track complete, including the furnishing iron

rails, weighing not less than fifty-six pounds to the yard, chairs, spikes, and cross-ties.

The Commonwealth shall permit the use by the contractors, without charge, for the purposes of the work herein specified, of the dam and canal, water-wheels, saw-mill, machine-shop, with its shafting, lathes, drills, benches and fixtures, compressors, and other machinery for power and ventilation, now set up and in use, with the buildings connected therewith, together with the pneumatic drills, air and water pipes, cross-ties, cars, and drill-carriages, which are now in use for the prosecution of the work: stipulating that the contractors shall keep all the same, at all times, in a complete state of repair and efficiency.

The contractors shall hereafter make such repairs, renewals, and additions, as shall appear to the officer in charge of the work necessary for durability or security, or for rapid prosecution of the work.

The Commonwealth will also hand over to the contractors all the tools of every description,—iron rails, steel, iron, powder, horses, mules, wagons, harnesses, and other materials, now provided, which are available for the work, and the contractors shall take and pay for them at a valuation to be agreed upon by the parties to this contract, or in case of their disagreement or failure to act, the valuation shall be made by two competent persons, one of whom shall be selected by the governor and council, and the other by the contractors, the arbitrators to choose an umpire in case of disagreement, said valuation to be fixed upon before the commencement of the work.

The Commonwealth will lease to the contractors, at a rent to be determined in the same way, the blacksmith's and other shops, with their fixtures for repairs of tools, cars, etc.

Such further buildings, machinery and material as may be needed for the work shall be provided by the contractors.

The material removed from the tunnel at both ends thereof, will be deposited wherever the Commonwealth, by its officers in charge of the work, shall direct, it being understood that in case the contractors shall be required to deposit the same in embankment or spoil bank on the east of the Deerfield River, they shall have the privilege of using the bridge to be erected by the Commonwealth under such reasonable restrictions as may be required; and the contractors shall not be required to haul the same more than 3,000 feet from either end of the tunnel.

The contractors shall from and after the commencement of work under this contract employ the necessary force of miners, laborers,

&c., and shall maintain average rates of advance on each of the several sections, described as follows:—

- 1st. On the tunnel enlargement, 75 feet per month.
- 2d. On the heading enlargement, 75 feet per month.
- 3d. Extension of full size tunnel, 125 feet per month.
- 4th. Excavation and construction of central drain, and laying pipes through the tunnel, 150 feet per month, or not more than 500 feet behind the advanced heading.

The work of each separate section described shall be commenced at the west end of work completed by the State, and thence carried with a completed advance westward, reserving always to the contractors the privilege of working two or more breasts on each one of the sections described, in order to make up the aggregate rate of progress required in each.

Temporary use of timber for covering central drain, as heretofore found convenient, will still be permitted, but permanent stone coverings must be provided and put in place, in advance of any allowance for track-laying.

Estimates will be made only of quantities within the exterior lines prescribed for the tunnel.

Any material detached by blasting or otherwise outside of said lines must be removed by the contractors without charge.

II.—CENTRAL SECTION.

The work already done consists in the sinking of 583 feet of the shaft, which is intended to have a total depth of about 1,030 feet to floor of tunnel, with such additional depth as may be deemed necessary for a sump.

The shaft is of an elliptical form, 27 feet in diameter on line of tunnel by 15 feet transverse diameter, making an area of about 318 square feet, or $11\frac{3}{4}$ cubic yards per foot of depth.

Work to be done is

- 1st. To construct over the shaft a fire-proof floor with self-closing iron hatches.
- 2d. To repair and complete timbering and finish excavation to present depth of shaft.
- 3d. To sink the shaft to floor of tunnel.
- 4th. To set up two 10-inch iron pipes, for purposes of power and ventilation.
- 5th. To sink the sump below floor of tunnel.

6th. To excavate a tunnel east and west therefrom until it shall meet workings respectively from east end and west shaft.

7th. To construct the central drain, with air and water pipes complete, as shown on drawings exhibited at engineer's office, a copy of which is annexed hereto.

8th. Laying one track complete, including the furnishing iron rails, weighing not less than fifty-six pounds to the yard, chairs, spikes, and cross-ties.

The contractors shall complete the shaft to the floor of the tunnel by the first day of May, 1870.

They shall, before June 1, 1870, furnish and set in place the additional machinery, compressors, &c., requisite to maintain in the power pipe a constant pressure of 50 pounds per square inch while supplying in each heading the continuous working of 8 pneumatic drills, and also provide requisite air-pumps of power sufficient to furnish through the ventilation pipe the proper air supply for the ventilation of each of the headings.

They shall employ suitable force, and shall maintain, after June 1, 1870, an average rate of monthly progress of tunnel excavated to full size, east and west, of not less than 80 feet in each direction.

All excavations from shaft or headings shall be deposited where directed by the engineer.

Price paid per linear foot of depth of shaft will include cost of sinking the shaft and removal of material to spoil banks as shall be required, and of such additional timbering, framework, &c., as may be necessary for arrangement of pumps, hoisting apparatus, and other machinery required.

The contractors will have the privilege of using without charge all the machinery designed for purposes of hoisting, pumping, ventilation, &c., already erected by the Commonwealth, and also the buildings over the shaft, the machine-shop, and machinery, water pipes, drains, &c.

They shall constantly maintain the same in good condition by repairs and renewals, and return the same in good order at the expiration of their contract.

They will supply at their own expense the additional hoisting, pumping, ventilating and drilling machinery which may be required, excavate the spaces for, and furnish tanks, and also place ladders and other constructions and devices for escape and safety as required by the officers of the Commonwealth in charge of the work.

They may occupy and use the saw-mill, and blacksmith's and other shops erected by the Commonwealth, except such as may be

reserved by the officers of the Commonwealth in charge, shall keep the same constantly in repair, and pay therefor a rent, to be established in same manner as is provided in the case of rents at the east end.

All horses, mules, wagons, tools, steel, iron and iron rails, powder, lumber and other materials provided by the Commonwealth, which are available for their work, shall be taken by them, at a valuation to be fixed upon before they shall commence the work, and to be ascertained, in case the parties do not agree, by arbitrators, chosen in same manner as provided for at east end.

III.—WEST END SECTION.

The work already done consists of a shaft 318 feet deep, having a section of 8 by 14 feet, from which headings have been extended about 1,609 feet east and westward to west end, and of a supplementary shaft 264 feet distant to the west therefrom and 277 feet deep, used only for purposes of pumping, and of an auxiliary shaft 685 feet farther to the west and 215 feet deep, through which the material of west heading may be hoisted until an opening can be made to west end.

From the present western end of the tunnel, a distance of about 860 feet has been completed by B. N. Farren, contractor, who has existing contracts, upon which he is now engaged and under which he is to complete the tunnel to a point 931 feet east of west end on or before the 1st day of June, 1869.

The Work to be done under these Specifications consists in

1st. Enlargements of the headings already driven, and of the adit to the full size section of the tunnel. Estimated amount—52,800 cubic yards.

2d. Extension of a full size tunnel eastward until it shall meet the workings in opposite direction from the central shaft.

3d. Arching part of the tunnel with sound and hard-burned bricks. Amount of bricks to be laid not to exceed 4,500,000.

4th. Construction of the central drain, and in furnishing and laying the air and water pipes therein.

5th. Excavating for and constructing fifty linear feet of stone arch additional, and joined on to the present west end of brick arch, on such plan as may be furnished by the engineer or engineers, supported on foundations to be approved by the engineer or engineers, and properly filling over the same.

6th. Excavating for and constructing of granite a suitable façade to the tunnel on such plan as may be furnished by the engineer or

engineers, to contain about 800 cubic yards, and properly filling around the same.

7th. Clearing out and securely timbering the Haupt tunnel, so called, and maintaining the same until the completion of this contract.

The construction of the stone arch and the façade, being numbers 5 and 6 of the specifications for this section, is not to be commenced until the same is ordered by the governor and council.

8th. Furnishing and laying one track, including rails, chairs, spikes and cross-ties complete, according to specifications for track provided under head of General Stipulations.

The contractors shall employ suitable force, and shall maintain, after May 1st, 1869, an average rate eastward of monthly progress of tunnel excavated to full size of not less than 100 feet.

The contractors will have the privilege of using without charge all the machinery designed for purposes of hoisting, pumping, power and ventilation, &c., already erected by the Commonwealth, and also the buildings over the shaft, machine-shop, with the shafting, lathes, drills, benches and fixtures and machinery, cars, pneumatic drills and drill carriages, water pipes, drains, &c., stipulating that they shall keep the same at all times in a complete state of repair and efficiency.

The contractors hereafter shall make such repairs, renewals and additions as shall appear to the officers in charge of the work necessary for durability or security, or for rapid prosecution of the work.

The Commonwealth will also hand over to the contractors all the tools of every description—steel, iron and iron rails, powder, horses, mules, wagons, harnesses, and other materials, now provided, available for work; and they shall take and pay for them at a valuation to be fixed upon before they shall commence the work, and to be ascertained, in case the parties do not agree, by arbitrators, chosen in the same manner as provided for at east end.

The Commonwealth will lease to the contractors, at a rent to be determined in the same way, the blacksmith's and other shops, with their fixtures for repairs of tools, cars, etc.

Such further buildings, machinery and material as may be needed for the work shall be provided by the contractors.

Estimates will be based upon quantity of material which lies within the line of section prescribed by the engineer or engineers, and any material falling from outside of these lines, whether detached by blasts or falls, must be removed by the contractors without charge.

It being understood that where the engineer or engineers shall become satisfied that outside timber support is needed during the construction of the arch, he shall prescribe lines of section one foot outside of brick arch, as an allowance of space for timbering.

Dimensions and thickness of the successive portions of the brick arch will be prescribed by the officers of the Commonwealth in charge of the work as the same progresses.

Price per cubic yard for excavation of tunnel shall include all cost of temporary supports, pumping, drainage, power, ventilation and all material and labor and appliances requisite therefor, in addition to those which have already been provided,—and also cost of hauling and depositing the excavated material as the engineer shall direct.

Price per M for bricks laid in arch shall include cost of timber for support, framing centres, labor, cement, sand, and all materials and labor requisite for making the arch complete.

Quality of bricks, mode of mixing and using mortar, and quality and proportions of cement and sand shall be such as shall be prescribed and approved by the officers in charge of the work.

The contractors shall promptly remove and properly rebuild any work found bad or imperfect, or not in conformity with lines, grades and plans furnished.

All holes or vacancies outside of brick arch must be closely packed with stone of suitable size, by the contractors, without charge therefor.

All suitable bricks made at the State Brick Yard, during the present year, and not required by the Commonwealth or for Farren's contract, shall be supplied to the contractors and taken by them at \$9 per M, the same to be taken out of the amount due upon current monthly estimates.

The bricks are to be delivered at or near the yard, counted in piles, and thenceforward all loss or breakage in transportation or otherwise to be borne by the contractors.

IV.—GENERAL STIPULATIONS.

Applicable to each of the foregoing divisions of the work:—

The dwellings and store-houses of all kinds erected at the east end, central shaft, and west end, except such as may be already disposed of or may be reserved by the officers of the Commonwealth in charge of the work, to be rented of the Commonwealth by the contractors, at the same rents as heretofore established, and the amount retained out of their monthly payments.

Measurements definitely establishing the present condition of the tunnel and other work shall be made before the contractors commence upon the same.

Monthly estimates to be made by the engineer or engineers of the amount and value of work done during the month preceding; and at the completion of the work a final estimate shall be made by the engineer or engineers of the whole amount appearing to be due under this contract.

In case it shall appear at any time during the progress of the work that machinery provided at any point is not longer necessary there for the purposes of the work, then it shall be in the discretion of the officers in charge of the work to remove the same, if it be of the property provided by the State.

The work to be done under the direction and to the entire satisfaction of the governor and council as indicated through the officers in charge of the work.

The contractors shall use their best efforts to keep intoxicating liquors from their employees, and to promote orderly conduct among them; and shall, when required by the engineer, discharge any men who shall be careless, negligent, or incompetent, or guilty of conduct prejudicial to good order.

An employee once discharged for misconduct shall not be again employed upon the work without the consent of the engineer or engineers.

The prices heretofore named for rates of progress provide for all constructions, machinery, material and labor, &c., and for the cost of all accessory works requisite for the completion of the work described in these specifications, all of which shall be supplied by the contractors.

As a more rapid progress of the work is required than drilling by hand labor would accomplish, upon each of the advance headings, between the east portal and west shaft, the contractors will be required to use the pneumatic drills, working continuously not less than eight drills to a heading of eight feet height, with not less than fifty pounds air pressure, but with the liberty to employ the form of machine now in use in the tunnel or any other drill of equal efficiency which they may prefer, and provide at their own expense.

The contractors shall keep the completed portions of their work clear of all obstructions; and shall, whenever required by the engineer or engineers, remove from the tunnel and shaft all machinery, fixtures, and material not needed for their work.

The track to be laid shall in all respects conform with the specifications in Farren's contract for the track of the Troy and Greenfield

Railroad east of the tunnel, and shall not be laid or paid until the tunnel is completed.

The parties of the first part shall, at their own cost and charge, cause the buildings and property of the Commonwealth which is allowed to the contractors without charge, to be insured against loss or damage by fire, in such reasonable amounts as shall be approved by the governor and council. The policies to be payable to the Commonwealth in case of loss. All moneys collected on such policies to be applied to the restoration of such property. But in no event is the Commonwealth to be further chargeable for such restoration.

It is understood and agreed, that the Commonwealth is in no event to be responsible for the correctness of the estimates of quantities, distances, etc., given in this schedule, nor shall the specific details of work to be done, as given herein, be construed in any manner to relieve the contractors from the full and complete performance of the entire work of the completion of the Hoosac Tunnel, exclusive of the part now under contract to B. N. Farren, to be performed under this contract, nor in any way affect the gross amount to be paid by the Commonwealth to the contractors, as stated in the contract.

The foregoing schedule, contained in pages 6 to 12, is the schedule referred to in the body of the contract for the completion of the Hoosac Tunnel, executed this day, Dec. 24, 1868.

ALEXANDER H. BULLOCK, *Governor.*
W. SHANLY.

COMMONWEALTH OF MASSACHUSETTS.

SECRETARY'S DEPARTMENT, BOSTON, December 24, 1868.

I hereby certify that the above is a true copy.

OLIVER WARNER, *Secretary.*





ELEVENTH ANNUAL REPORT

OF THE

MANAGER

OF THE

TROY & GREENFIELD RAILROAD

AND HOOSAC TUNNEL

FOR THE

YEAR ENDING SEPT. 30, 1885.

BOSTON :

WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE.

1886.

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18 POST OFFICE SQUARE.

1886.

OFFICERS OF THE ROAD.

Manager:

A. W. LOCKE.

Treasurer:

AUSTIN BOND.

Train Master:

CHARLES W. PURCELL.

Engineer of Maintenance of Way:

HOBART B. POTTER.

Commonwealth of Massachusetts.

REPORT.

The Manager of the Troy and Greenfield Railroad and Hoosac Tunnel has the honor to submit to the Legislature the following report for the year ending Sept. 30, 1885, in accordance with the provisions of chapter 141 of the Acts of 1879 : —

The income from traffic (50 per cent. of the gross earnings) is	\$276,692 08
The income from all other sources is	36,590 23
	<hr/>
The total income from all sources is	\$313,282 31
Expended by the Manager :	
In the operation of the road,	\$239,580 71
In performing various services for other roads for which payment has been collected,	22,176 25
	<hr/>
Total expenses other than construction authorized by law,	261,756 96
	<hr/>
Net earnings,	\$51,525 35
Expended by the Manager for construction authorized by law :	
Second track east of Hoosac Tunnel : Balance of appropriation,	35,709 66

The above information may be found accompanied by full details in the report of the Treasurer annexed hereto.

The expenditures have been larger than last year, chiefly on account of lawsuits, by reason of which an expense of \$21,800.09 has been incurred. Also a considerable amount

of work, such as ditching and surfacing new track, has been done and charged to repairs. This would have properly been charged to construction if the appropriation had not been exhausted.

DOUBLE TRACK.

The double track was finished and put into use on May 1, 1885.

The following are some of the items of work done in connection with the second track during the year: —

Track laid and put into use,	3 $\frac{82}{100}$ miles.
Earth excavation, including ballast,	10,816 yards.
Solid rock excavation,	2,497 "
Iron bridges over 10 feet span,	1
Number of spans counted as single track,	6
Total length of bridges, counted as single track,	586 feet.

The following shows the cost of some of the work: —

Earth excavation, including ballast, per yard,	\$0 23
Solid rock excavation, per yard,	1 37
Laying track, per mile,	518 89
Bardwell's bridge, total cost of new work,	25,410 57

The amounts appropriated and expended for double track-
ing the road are as follows, beginning in 1879: —

	Appropriations.	Expenditures.
To October 1, 1884,	\$991,133 00	\$955,423 34
No appropriation made in 1885.		
Expended Oct. 1, 1884 to Oct. 1, 1885,	—	35,709 66
Total,	\$991,133 00	\$991,133 00
Expended from T. & G. R.R. fund,	—	\$85,000 00
Expended from the earnings of the road,	—	125,581 00
Expended from the Treasury,	—	780,552 00
Total,	—	\$991,133 00

No further appropriations are needed at present.

The road is now in condition to allow all the business to move promptly, which will come upon it.

CARE AND OPERATION OF THE RAILROAD AND TUNNEL.

In addition to the completion of the second track, a new interlocking system of switches and signals has been erected at Conway Junction, where the New Haven & Northampton track joins this road. Also the bridge over the Deerfield River, at that point, has been strengthened at a cost of \$5,781.55, in addition to being extended to double track width. All the bridges are now of iron with one exception.

About 81 feet of brick arch near the west portal of the Tunnel has been repaired at an expense of \$3,374.53, or \$41.66 per linear foot. Making a total of 187 feet repaired up to the present time, at a total expense of \$8,651.50 or \$46.26 per linear foot.

The roof of the Tunnel, where not arched, has been cared for as heretofore. Nothing has fallen upon the track.

New ties to the number of 18,673 have been placed in the track at an average price of fifty cents each delivered on the ground, and an additional cost of $8\frac{7}{10}$ cents each for the labor of placing them in the track after delivery.

About 200 tons new steel rails, weighing 67 pounds to the yard, have been laid.

About 3,500 feet of new side track has been laid at Bardwell's, Hoosac Tunnel, North Adams and Williamstown, but as several long sidings were turned into main track along the road, there was no increase in the total side track.

New fence has been built where needed to replace old, 465 rods in all, at an average cost of \$1.09 per rod.

The road has been ditched in those parts which had not previously been attended to, and the track is now well drained and in good order throughout.

The following table shows the expenses compared with previous years : —

YEARS.	Train miles.	Gross Earnings.	Expended by the Manager in Operating the Road.	Expense per Train Mile.	Expense per Dollar of Gross Earnings.
1879-80, . . .	358,652	\$434,417 15	\$123,760 55	\$0.345	\$0.285
1880-81, . . .	571,630	473,979 85	183,296 41	0.321	0.387
1881-82, . . .	599,691	453,773 67	171,064 18	0.285	0.377
1882-83, . . .	644,510	586,037 25	168,514 68	0.261	0.288
1883-84, . . .	697,726	597,789 51	192,430 61	0.275	0.322
1884-85, . . .	650,301	589,974 39	239,580 71	0.368	0.406

The gross earnings of the road from traffic have been, . . . \$553,384 16
 From other sources, including work done for the operating companies, 36,590 23
 \$589,974 39

Fifty per cent. of the gross earnings from traffic is retained monthly by the operating roads for their services.

OFFICERS AND EMPLOYEES.

The following table shows the number of officers and employees engaged upon the road September 30, 1885:—

STATIONS.	Greenfield.	West Deerfield.	Bardwell's.	Conway Junction.	Shelburne Falls.	Buckland.	Charlemont.	Zoar.	Hoosac Tunnel.	East Portal.	West Portal.	North Adams.	Braytonville.	Blackinton.	Williamstown.	Cole's Switch.	Vermont.	Total.
Manager, . . .	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Treasurer, . . .	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Train Master, . . .	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Engineer M of Way, . . .	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Track Supervisor, . . .	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Timekeeper, . . .	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Station Agents, . . .	1	1	1	-	1	1	1	1	1	-	-	1	-	1	1	-	-	11
Car Record Clerks, . . .	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	10
Clerks,	4	-	-	-	2	-	-	-	1	-	-	13	-	-	-	-	-	20
Ticket Agents, . . .	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2

OFFICERS AND EMPLOYEES — *Concluded.*

STATIONS.	Greenfield.	West Deerfield.	Bardwell's.	Conway Junction.	Shelburne Falls.	Buckland.	Charlemont.	Zoar.	Hoosac Tunnel.	East Portal.	West Portal.	North Adams.	Braytonville.	Blackinton.	Williamstown.	Cole's Switch.	Vermont.	Total.
Warehousemen, . . .	7	-	-	-	2	-	-	-	-	-	-	15	-	-	-	-	-	24
Baggage Masters, . .	2	-	-	-	1	-	-	-	-	-	-	3	-	-	1	-	-	7
Telegraph Operators, .	1	-	-	2	2	-	2	-	-	2	2	3	-	-	1	-	2	17
Englnemen,	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	2
Firemen,	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	2
Foremen,	1	-	1	-	2	-	2	-	1	1	1	1	-	-	1	-	-	11
Trackmen,	7	-	8	-	10	-	10	-	4	7	8	16	-	-	6	-	-	76
Track Watchmen, . .	1	-	1	-	2	-	2	-	1	2	2	1	-	-	1	-	-	13
Laborers,	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	5
Flagmen,	1	-	-	-	2	-	1	-	-	-	3	3	1	2	1	1	-	15
Miners,	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	5
Watchmen,	-	-	-	-	1	-	-	-	-	-	-	2	-	-	-	-	-	3
Telegraph Repairman,	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Janitors,	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2
Blacksmiths,	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2
Helpers,	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2
Foremen,	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	2
Carpenters,	-	-	-	-	5	-	-	-	-	-	-	4	-	-	-	-	-	9
Yard Foremen,	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	3
Yard Brakemen, . . .	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-	-	-	11
Yard Masters,	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2
Telegraph Messenger, .	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Machinists,	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2
Switchmen,	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	6
Assistant Engineer, . .	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
Rodmen,	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2
Conductor,	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Train Brakemen, . . .	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3
Masons,	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	4
Ledgemen,	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	8
Total,	27	1	11	2	54	1	18	1	8	12	21	116	1	3	12	1	2	291

BUSINESS OF THE ROAD.

Table showing the movement of freight cars through the Tunnel : —

	East Bound.	West Bound.	Total.
Loaded cars,	81,193	36,477	117,670
Empty cars,	2,188	47,002	49,190
Totals,	83,381	83,479	166,860

The largest month's freight business was 16,307 cars in October, 1884 ; the largest day's business was 698 cars Oct. 31, 1884 ; and the largest number of loaded freight cars was 481 on May 25, 1885.

The number of trains through the Tunnel has been as follows : —

Passenger,	4,824
Mixed,	307
Freight,	5,670
Light engines,	274
Construction,	255
Total,	11,330

An average of 36 trains per day, not including Sundays.

The total trains handled at North Adams daily averaged 86, of which 50 ran west and 36 east of that station, not including 7 pushing engines daily which only ran to West Portal.

Table showing the miles run on the road during the year : —

	Passenger Train Mileage.	Freight Train Mileage.	Construction Train Mileage.	Light Engine Mileage.	Pushing Mileage.	Double Header Mileage.	Switching Mileage.	Total Engine Mileage.
Fitchburg R. R., . . .	111,931	194,066	-	13,407	4,216	3,007	-	326,627
New Haven & Northamp- ton Co.,	53,707	17,888	-	335	2	-	-	71,932
Troy & Boston R. R., . .	22,106	14,014	-	532	-	84	-	36,736
Boston, Hoosac Tunnel and Western Railway, . . .	25,130	42,565	-	4,465	-	763	-	72,923
Troy & Greenfield R. R. and Hoosac Tunnel, . .	-	-	24,000	-	-	-	-	24,000
Switching miles of all roads at North Adams and Greenfield,	-	-	-	-	-	-	118,080	118,080
Total,	212,874	268,533	24,000	18,739	4,218	3,854	118,080	650,298

Switching and construction engines are allowed 60 miles a day.

Table showing the freight and passenger traffic of the road for the year : —

	Passengers Carried.	Passenger Mileage.
Local East bound,	129,159	1,333,267
Through East bound,	31,714	1,386,718
Total East bound,	160,873	2,719,985
Local West bound,	128,014	1,660,103
Through West bound,	38,401	1,678,632
Total West bound,	166,415	3,338,735
Total local passengers,	257,173	2,993,370
Total through passengers (to and from other roads),	70,115	3,065,350
Total passengers carried,	327,288	6,058,720

	Tons Freight Moved.	Tonnage Mileage.
Local East bound,	177,220	2,128,106
Through East bound,	1,029,086	44,840,112
Total East bound,	1,206,306	46,968,218
Local West bound,	35,948	668,101
Through West bound,	175,806	7,685,688
Total West bound,	211,754	8,353,789
Total local freight,	213,168	2,796,207
Total through freight (to and from other roads),	1,204,892	52,525,800
Total freight moved,	1,418,060	55,322,007

Freight upon which no revenue has been collected : —

	Tons Freight Moved.	Tonnage Mileage.
East bound,	10,328	329,605
West bound,	1,275	33,608
Total,	11,603	363,213

COMPARISON WITH LAST YEAR.

Increase in the movement of freight cars through the Tunnel,	$\frac{1}{4}$ per cent.
Decrease in the movement of loaded freight cars through the Tunnel,	$1\frac{1}{4}$ "
Percentage of loaded freight cars through the Tunnel,	$70\frac{1}{2}$ "
Percentage of empty freight cars through the Tunnel,	$29\frac{1}{2}$ "
Decrease in passenger trains through the Tunnel,	$\frac{1}{2}$ "
Decrease in freight and mixed trains through the Tunnel,	$2\frac{1}{8}$ "
Increase in passenger mileage on the road,	7 "
Increase in freight tonnage mileage on the road,	$4\frac{1}{2}$ "
Gross earnings from passengers,	\$132,572 56
Gross earnings from freight,	405,873 32
Rate per mile per passenger,	$2\frac{19}{100}$ cents.
Rate per mile per revenue ton of freight,	$7\frac{3}{10}$ mills.
Average miles hauled each passenger,	$18\frac{51}{100}$ miles.
Average miles hauled each ton of freight,	$39\frac{1}{100}$ "

As remarks have been made in the public prints and elsewhere concerning the small net earnings of the road, it seems proper to say here that the reason for such small earnings is that the freight is hauled at an extremely low rate.

The average price charged for moving freight as above shown is much lower than the average of any other road in the State; and less than half the average of all the roads in the State last year.

With most roads the average rate is largely increased by local business, but with us it is not so, as the operating companies compete with each other over the State road as well as their own for much of the local business; as they have a right to do under the existing contracts. In some cases the rates have been lower for local freight than for through freight of the same class. For example, thousands of carloads of local freight have been hauled over portions of the road for seven and one-half mills per ton mile, while the same kind of freight going through has paid this road nine mills per ton mile.

The present time-honored policy of inviting competition upon the State tracks will probably have to be abandoned before any large increase in the rates can be brought about. But if a larger income could be obtained by arbitrarily raising the rates, our own citizens would have to pay the increase for the most part.

If the object in constructing the tunnel and road was cheap transportation, that seems to be accomplished. But, if a large direct revenue is desired, then a system different from the present one appears to be required.

For the year ending September 30, 1883, the Railroad Commissioners awarded to the four operating roads $50\frac{29.5}{1000}$ per cent. of the gross earnings, and for the year ending September 30, 1884, $54\frac{8.9}{100}$ per cent. These awards have not been accepted, but are still in dispute.

ACCIDENTS.

No accident has happened to any train. One passenger fell from a passenger car in the Tunnel while carelessly standing upon the steps, and received injuries from which he afterwards died.

WORK OF THE COMING YEAR.

The following is an estimate of the necessary operating expenses for the year ending September 30, 1886:—

Salaries and wages,	\$10,000 00
Legal expenses,	2,000 00
Stationery and printing,	2,000 00
Contingencies and miscellaneous,	2,000 00
Repairs of bridges,	3,500 00
Repairs of buildings,	5,000 00
Repairs of fences, road crossings and signs,	800 00
Renewal of ties,	12,000 00
Renewal of rails,	15,000 00
Repairs of road-bed and track,	75,000 00
Repairs of locomotives,	3,000 00
Fuel for locomotives,	1,500 00
Water supply,	2,500 00
Oil and waste,	1,000 00
Locomotive service,	2,000 00
Repairs of flat and dump cars,	700 00
Telegraph expenses,	15,000 00
Agents and station service,	33,000 00
Station supplies,	4,000 00
Switching in North Adams yard,	15,000 00
Car record office,	5,000 00
	<hr/>
	\$210,000 00

MISCELLANEOUS INFORMATION.

Length of road,	44 miles.
Tangent,	25 "
Curve,	19 "
Proportion of curve	43 per cent.
Maximum curve,	6°
Length of double track,	44 miles.
Length of sidings,	22 $\frac{52}{100}$ "
Total track including main and side tracks,	110 $\frac{52}{100}$ "
Maximum grade going East per mile,	42 $\frac{24}{100}$ feet.
Maximum grade going West per mile,	49 $\frac{66}{100}$ "
Number of spans of wooden bridges over 25 feet,	3
Number of spans of iron bridges over 25 feet,	37
Total bridging computed as single track not counting spans under 25 feet,	6,318 feet.
Number of stations,	11
Number of telegraph offices,	15

Telegraph line owned by the Commonwealth,	. . . . .	46 miles.
Number of locomotives	. . . . .	4
Number of dump cars,	. . . . .	55
Number of flat cars,	. . . . .	12
Number of wrecking cars,	. . . . .	1
Number of saloon cars,	. . . . .	3
Number of snow-ploughs,	. . . . .	2
Number of derrick cars,	. . . . .	1

Respectfully submitted.

A. W. LOCKE,
Manager.

NORTH ADAMS, MASS., Dec. 31, 1886.

REPORT OF THE TREASURER.

NORTH ADAMS, Dec. 21, 1885.

A. W. LOCKE,

Manager of the Troy and Greenfield Railroad and Hoosac Tunnel :

SIR : — I herewith submit the following report of the earnings and expenditures upon the Troy & Greenfield Railroad and Hoosac Tunnel, for the year ending Sept. 30, 1885.

The operating roads have paid as tolls fifty per cent. of the gross earnings on the Troy & Greenfield Railroad and Hoosac Tunnel, as follows : —

TOTAL EARNINGS FOR THE YEAR.

Fitchburg Railroad Co.

For passengers,	\$43,077 40
freight,	158,895 52
mail service,	3,281 21
express and extra baggage,	2,606 48
	————— \$207,860 61

Boston, Hoosac Tunnel & Western Railway.

For passengers,	\$6,712 38
freight,	21,647 58
express and extra baggage,	327 07
	————— 28,687 03

Troy & Boston Railroad Co.

For passengers,	\$7,301 99
freight,	9,134 03
mail service,	708 00
express and extra baggage,	320 90
	————— 17,464 92

<i>Amount carried forward,</i>	\$254,012 56
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Amount brought forward, \$254,012 56

New Haven & Northampton Co.

For passengers,	\$9,194 51	
freight,	13,259 53	
express and extra baggage,	225 48	
		22,679 52
For rent of stations and other property,		5,669 69
old material, etc. (sold),		9,435 06
interest on bank account,		265 10
use of telegraph poles,		219 00
amount refunded,		75 13
50 per cent. receipts from Western Union Tel. Co.,		549 61
amount received of operating roads for cleaning ash pit,		232 00
“ “ “ “ telegraph service,		1,020 00
“ “ “ “ car record expense,		5,665 76
“ “ “ “ handling freight at Greenfield,		4,139 80
total amount received for switching cars,	\$13,577 43	
Less amount charged by Fitchburg R. R. Co. for switching cars at Greenfield in 1884,	4,258 35	
		9,319 08
		\$313,282 31
Deduct total expenses,		261,756 96
Net earnings,		\$51,525 35

Received for Tolls from Fitchburg Railroad Company.

	Freight.	Passenger.	Express and Extra Baggage.	Mail Service.	Total.
1884.					
Oct.,	\$16,192 72	\$4,818 00	\$257 61	—	\$21,268 33
Nov.,	14,396 46	3,203 87	184 05	—	17,784 38
Dec.,	13,768 15	2,793 35	180 99	\$904 52	17,647 01
1885.					
Jan.,	12,186 70	2,316 17	158 53	—	14,661 40
Feb.,	9,270 56	1,949 74	147 83	—	11,368 13
March.,	16,829 90	2,464 65	181 03	904 52	20,380 10
April.,	14,009 42	2,799 74	221 49	—	17,030 65
May.,	12,682 46	2,717 52	209 12	—	15,609 10
June.,	11,410 11	3,518 15	198 52	567 65	15,694 43
July.,	12,621 58	4,323 12	223 13	—	17,167 83
Aug.,	12,147 34	6,041 53	215 03	—	18,403 90
Sept.,	13,380 12	6,131 56	429 15	904 52	20,845 35
	\$158,895 52	\$43,077 40	\$2,606 48	\$3,281 21	\$207,860 61

Received for Tolls from Boston, Hoosac Tunnel & Western Railway.

	Freight,	Passenger.	Express and Extra Baggage.	Mail Service	Total.
1884.					
Oct., .	\$2,245 28	\$793 79	\$13 63	-	\$3,082 70
Nov., .	1,938 20	611 78	25 81	-	2,575 79
Dec., .	1,828 32	468 79	22 09	-	2,319 20
1885.					
Jan., .	1,792 35	397 10	15 30	-	2,204 75
Feb., .	1,407 91	311 35	12 59	-	1,731 85
March, .	2,056 93	343 09	12 02	-	2,412 04
April, .	1,741 84	405 80	19 78	-	2,167 42
May, .	1,642 83	389 05	21 20	-	2,053 08
June, .	1,699 70	467 58	18 79	-	2,186 07
July, .	1,786 40	822 01	26 39	-	2,634 80
Aug., .	1,679 13	880 61	20 61	-	2,580 35
Sept., .	1,828 69	821 43	88 86	-	2,738 98
	\$21,647 58	\$6,712 38	\$327 07	-	\$28,687 03

Received for Tolls from Troy & Boston Railroad Company.

	Freight.	Passenger.	Express and Extra Baggage.	Mail Service.	Total.
1884.					
Oct. . .	\$900 07	\$687 79	\$30 11	-	\$1,617 97
Nov., .	736 65	512 00	25 09	-	1,273 74
Dec., .	684 05	528 72	28 25	\$177 00	1,418 02
1884.					
Jan., .	461 77	461 13	21 12	-	944 02
Feb., .	556 13	364 48	19 16	-	939 77
March, .	830 95	500 89	23 58	177 00	1,532 42
April, .	928 54	567 04	30 28	-	1,525 86
May, .	863 33	571 75	29 78	-	1,464 86
June, .	708 99	636 53	30 25	177 00	1,552 77
July, .	747 47	736 19	28 21	-	1,511 87
Aug., .	823 78	857 08	24 24	-	1,705 10
Sept., .	892 30	878 39	30 83	177 00	1,978 52
	\$9,134 03	\$7,301 99	\$320 90	\$708 00	\$17,464 92

Received for Tolls from New Haven & Northampton Company.

	Freight.	Passenger.	Express and Extra Baggage.	Total.
1884.				
Oct., . . .	\$1,311 69	\$797 11	\$18 79	\$2,127 59
Nov., . . .	1,020 55	668 78	18 79	1,708 12
Dec., . . .	1,116 53	632 14	18 79	1,767 46
1885.				
Jan., . . .	786 76	581 89	18 79	1,387 44
Feb., . . .	776 15	444 88	18 79	1,239 82
March, . . .	1,278 32	608 50	18 79	1,905 61
April, . . .	1,005 72	700 22	18 79	1,724 73
May, . . .	985 38	668 74	18 79	1,672 91
June, . . .	1,277 97	789 43	18 79	2,086 19
July, . . .	1,149 23	1,020 94	18 79	2,188 96
Aug., . . .	1,234 03	1,269 97	18 79	2,522 79
Sept., . . .	1,317 20	1,011 91	18 79	2,347 90
	\$13,259 53	\$9,194 51	\$225 48	\$22,679 52

Received for Tolls.

	From F. R. R. Co.	From B. H. T. & W. R'y.	From T. & B. R. R. Co.	From N. H. & N. Co.	Total.
1884.					
Oct., . . .	\$21,268 33	\$3,082 70	\$1,617 97	\$2,127 59	\$28,096 59
Nov., . . .	17,784 38	2,575 79	1,273 74	1,708 12	23,342 03
Dec., . . .	17,647 01	2,319 20	1,418 02	1,767 46	23,151 69
1885.					
Jan., . . .	14,661 40	2,204 75	944 02	1,387 44	19,197 61
Feb., . . .	11,368 13	1,731 85	939 77	1,239 82	15,279 57
March, . . .	20,380 10	2,412 04	1,532 42	1,905 61	26,230 17
April, . . .	17,030 65	2,167 42	1,525 86	1,724 73	22,448 66
May, . . .	15,609 10	2,053 08	1,464 86	1,672 91	20,799 95
June, . . .	15,694 43	2,186 07	1,552 77	2,086 19	21,519 46
July, . . .	17,167 83	2,634 80	1,511 87	2,188 96	23,503 46
Aug., . . .	18,403 90	2,580 35	1,705 10	2,522 79	25,212 14
Sept., . . .	20,845 35	2,738 98	1,978 52	2,347 90	27,910 75
	\$207,860 61	\$28,687 03	\$17,464 92	\$22,679 52	\$276,692 08

Received for Tolls.

	Freight.	Passenger.	Express and Extra Baggage.	Mail Service.	Total.
1884.					
Oct., .	\$20,649 76	\$7,096 69	\$350 14	—	\$28,096 59
Nov., .	18,091 86	4,996 43	253 74	—	23,342 03
Dec., .	17,397 05	4,423 00	250 12	\$1,081 52	23,151 69
1885.					
Jan., .	15,227 58	3,756 29	213 74	—	19,197 61
Feb., .	12,010 75	3,070 45	198 37	—	15,279 57
March.,	20,996 10	3,917 13	235 42	1,081 52	26,230 17
April, .	17,685 52	4,472 80	290 34	—	22,448 66
May, .	16,174 00	4,347 06	278 89	—	20,799 95
June, .	15,096 77	5,411 69	266 35	744 65	21,519 46
July, .	16,304 68	6,902 26	296 52	—	23,503 46
Aug., .	15,884 28	9,049 19	278 67	—	25,212 14
Sept., .	17,418 31	8,843 29	567 63	1,081 52	27,910 75
	\$202,936 66	\$66,286 28	\$3,479 93	\$3,989 21	\$276,692 08

ANALYSIS OF EXPENSES.

Salaries and wages of general officers and clerks, . . .	\$12,209 33
Legal expenses and personal injuries, . . .	21,800 09
Stationery and printing, . . .	1,470 88
Contingencies and miscellaneous, . . .	2,540 39
Repairs of bridges, . . .	6,943 35
Repairs of buildings, . . .	8,388 21
Repairs of fences, road crossings and signs, . . .	1,821 50
Renewal of ties, . . .	12,479 71
Renewal of rails, . . .	9,173 42
Repairs of road-bed and track, . . .	96,073 19
Repairs of locomotives, . . .	1,927 38
Fuel for locomotives, . . .	1,801 11
Water supply, . . .	2,627 28
Oil and waste, . . .	595 61
Locomotive service, . . .	2,300 91
Repairs of flat and dump cars, . . .	532 32
Telegraph expenses, . . .	14,499 80
Agents and station service, . . .	33,816 85
Station supplies, . . .	3,342 22
Switching in North Adams yard, . . .	20,525 37
Car record, . . .	6,770 21
Loss and damage to freight and baggage, . . .	117 83
	<hr/>
	\$261,756 96

Operating expenses, . . . \$239,580 71

Amounts expended for services to
other companies, for which pay-
ment has been received, as fol-
lows:—

Care of passenger station at North Adams, . . .	\$350 00	
Care of passenger station at Green- field, . . .	900 00	
Handling freight at Greenfield, . . .	4,139 80	
Car record expenses, . . .	5,665 76	
Telegraph operators, . . .	1,020 00	
Switching cars, . . .	9,319 08	
Cleaning ash-pit, . . .	232 00	
Telegraph receipts at stations, . . .	549 61	
	<hr/>	
	22,176 25	
	<hr/>	
	\$261,756 96	\$261,756 96
	<hr/>	<hr/>

Amount received for tolls for the year ending Sept. 30, 1885, . . .	\$276,692 08
Amount received from all other sources, . . .	36,590 23
	<hr/>
	\$313,282 31
Amount paid State Treasurer for the year, . . .	\$313,282 31
	<hr/>
	\$313,282 31
	<hr/>
	\$313,282 31

Am't received of State Treasurer to pay Oct. 1884 vouchers,	\$32,915	45
“ “ “ “ “ Nov. “ “	23,994	49
“ “ “ “ “ Dec. “ “	19,905	82
“ “ “ “ “ Jan. 1885 “	17,883	34
“ “ “ “ “ Feb. “ “	31,307	83
“ “ “ “ “ Mar. “ “	20,733	01
“ “ “ “ “ Apr. “ “	37,339	41
“ “ “ “ “ May “ “	23,040	30
“ “ “ “ “ June “ “	18,270	15
“ “ “ “ “ July “ “	39,655	23
“ “ “ “ “ Aug. “ “	16,453	91
“ “ “ “ “ Sept. “ “	15,967	68

\$297,466 62

Amount paid for expenses, \$261,756 96

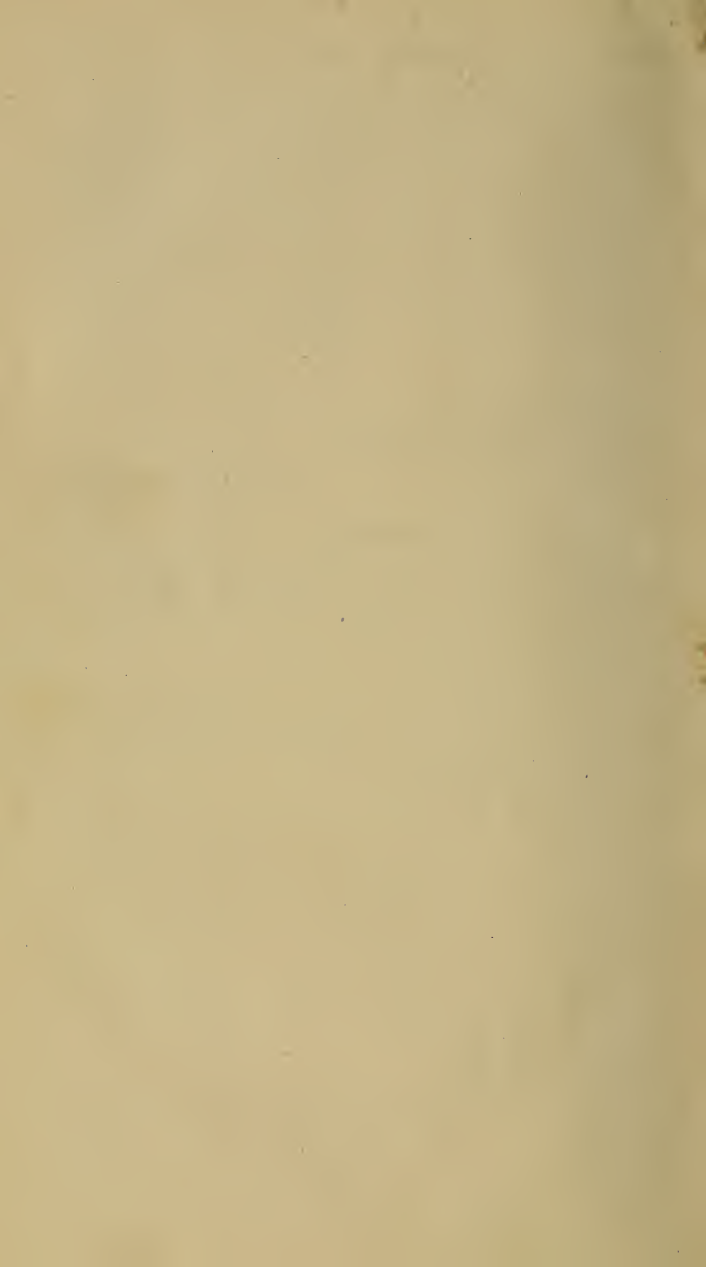
“ “ second track east of H. T., 35,709 66

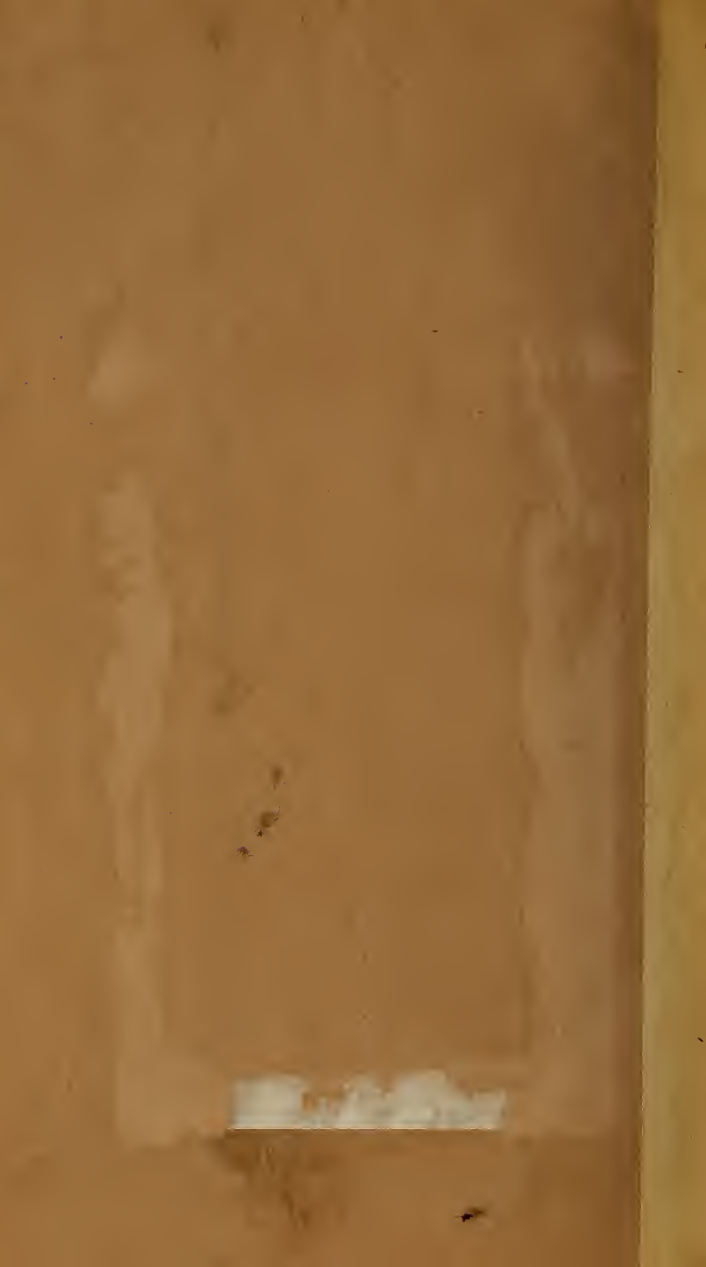
\$297,466 62 \$297,466 62

Respectfully,

AUSTIN BOND,

Treasurer.





R E P O R T

ON

TROY & GREENFIELD RAILROAD
SURVEYS.

JANUARY, 1874.

BOSTON:

WRIGHT & POTTER, STATE PRINTERS,
CORNER OF MILK AND FEDERAL STREETS.

1874.

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Commonwealth of Massachusetts.

EXECUTIVE DEPARTMENT, BOSTON, 20th January, 1874.

To the House of Representatives.

I have the honor herewith to lay before the General Court a Report of Surveys and Investigations relative to the Troy & Greenfield Railroad, made by Edward S. Philbrick, Civil Engineer, under instructions from the Governor and Council, given in pursuance of chapter 346, Acts of 1873.

W. B. WASHBURN.

MAP SHOWING
Proposed changes of location
in the
TROY & GREENFIELD R.R.
— EAST OF —
BARDWELL'S FERRY.



REPORT.

TO HIS EXCELLENCY WILLIAM B. WASHBURN, *Governor, and the Honorable Council.*

A sum was appropriated by the last general court, chapter 346, section 1, to be expended by the governor and council upon the Troy & Greenfield Railroad and Hoosac Tunnel, partly "in making such surveys and investigations as they may deem necessary to enable them to report to the next general court such plan as they think best for the interests of the Commonwealth to adopt in reference to said Tunnel and the Troy & Greenfield Railroad, and the probable cost of improving the same, and completing them for railroad service."

On the 5th of August last I was instructed to make such surveys and estimates as might be found necessary to a proper understanding of the case, and would now present my report.

I submit herewith a set of maps on a scale of 200 feet to an inch, showing present location of the Troy & Greenfield Railroad east of the Tunnel by a black line, and the proposed changes in blue and red lines; also a small map, to be printed herewith, showing alternative lines below Bardwell's Ferry by different surveys.

The history and general characteristics of the Troy & Greenfield Railroad are now tolerably familiar to a large number of our citizens. It is located in a narrow valley or gorge, alongside of a turbulent mountain-torrent, necessarily requiring very expensive works, and great thoroughness in their construction, to insure their permanence.

The original promoters of the enterprise were led, through lack of means, to bend all their energies upon keeping the first cost within certain limits, ignoring, or being unable to appreciate, the necessity of constructing durable work. So that, aside from the doubtful merits of the general location,

its details were carried out by the original company on a plan which was more commensurate with their means of payment, than likely to produce work suitable for future use.

The largest proprietor of the company being at the same time contractor and engineer, an unusual degree of concentration of talent and power was brought to bear upon the details of construction, which tended to produce a railroad line of the cheapest possible first cost, regardless of curvature and liability to wash, in a place requiring extraordinary expenditure to secure durability.

At the time when the State took possession of the property, so much work had been done in the construction, that it was thought best to complete it on the same general plan as begun, hoping it might stand till something better was needed; and since its completion the road has been kept passable, for the moderate amount of traffic developed, by dint of constant watchfulness and expenditure on the part of the lessees.

Some of the weak points in its construction were developed by the freshet of October, 1869, when the track was washed away, or rendered impassable, in fifty-nine separate places, some of which left gaps of five hundred feet length and sixty feet depth. More than half the culverts were torn out, and two spans of the bridge at Bardwell's Ferry carried off, with the pier between them.

The sum of \$142,160.21 was spent during the ensuing year by the lessees, and afterward refunded by the State, in repairing the line and rendering it passable. These repairs occupied a period of eleven months, during nine of which traffic was suspended.

Having been employed by His Excellency Governor Claflin, in June, 1870, to superintend these repairs, I made a report upon their completion, from which I quote the following, viz. :—

“The road is in some respects better able to resist the floods than ever before, inasmuch as new culverts have been built, in over twenty places, of largely increased opening, and on more secure foundations than before.

“But several miles of the embankment are exposed to the Deerfield River, a mountain torrent, which may at any time destroy all

such structures within its reach which are not thoroughly faced with stone.

"Several hundred carloads of loose rock have been picked up and applied to this purpose, so that, in this respect, the work is as well protected as before the great freshet of 1869, if not better, and therefore able to resist all ordinary stages of water.

"But another flood like that of October, 1869, or an unusual flood of even less dimensions, would be likely to destroy many of the embankments. There is scarcely any more broken stone left on the line of the road available for this sort of protection. I would therefore recommend an expenditure of some \$25,000 in bringing down the surplus stone from the Hoosac Tunnel as soon as a connection can be made with the present track.

"As the embankment this side of the tunnel will be finished during the coming year, at present rates of progress, a very large surplus of excellent material will become available for this purpose. Until such protection is effected, the road is at the mercy of the floods, and in no reliable condition for traffic."

In pursuance of this recommendation, an appropriation of \$25,000 was made in 1872 (chapter 287) for applying the protection spoken of, but on examination it was found that the location of the road was so faulty in most of the points where protection was needed, that it was thought best to risk further interruption by freshets, until the proper time should arrive for improving the location, and properly protecting it.* So that this sum was never drawn, nor any part of it.

During the past autumn I have inspected, on foot, every rod of the line from Greenfield to the Tunnel, not only for the purpose of forming an opinion of the present condition of the road, its safety and repair, but to study in detail such

* Since writing the above, I read for the first time a description of this location by Mr. J. W. Brooks, in the Report of the Commissioners upon the Troy & Greenfield Railroad and Hoosac Tunnel, of February 28, 1863, which I now quote in corroboration of what I had written above:—

"The line, as now located, is essentially a contractors' line,—such a one as might fairly be anticipated where the contractor and engineer were the same person, intensified, if possible, by his controlling a majority of the stock. Everything has apparently been sacrificed to save present outlay. That we do not advise the immediate abandonment of a considerable portion of it is, because of the large amount of work already done upon the most objectionable parts of the line, and the small amount of business to be done upon it until the Tunnel is completed, to which period, under existing circumstances, its improvement may be wisely deferred."—*Page 27 Commissioners' Report.*

changes of location as might be necessary to bring the line up to some definite standard in regard to curvature, which might be suitable to a road likely to have a considerable traffic, and at the same time within reasonable limits of expense.

Its condition as to repair is quite as low as, if not lower than, is consistent with the safety of the limited business now done upon it. The sleepers are very much decayed, especially on the eastern half, below Shelburne Falls, and the rails are all worn out, except for such short distances as it has been found absolutely necessary to replace them with new iron, for the sake of safety, proving their wretched quality when new, while the embankments, never finished at a liberal width, or with suitable materials, have been continually slipping away since first built, and have been merely kept in a passable condition. Very few have any shoulders beyond the ends of the sleepers, while the sleepers themselves project, in some cases, the earth having slipped away from under their ends, which are supported by blocking. This narrowness of embankments is not due to recent river-wash, for there has been no freshet worth mentioning since 1869, but is attributable to the clayey soil of which, and the careless way in which, they were first built, and the lack of proper drainage of their slopes. The cuttings are in many instances of slippery clay, the slopes of which had never been properly protected or drained, which breaks off every winter and spring, covering the track in many places, filling the ditches for long distances, and rendering proper drainage of the road-bed impossible.

Under such circumstances, it is not surprising to find that the lessees, whose interest expires with the coming year, should have hesitated to spend more upon repairs than the obligations of their lease and a proper regard for safety required. This state of things follows as a natural consequence of the original imperfect construction, with subsequent occupation by lessees who have no interest or apparent obligation to maintain the condition of the road above the requirements of the immediate safety of their small traffic.

As to improvements to be made in the character of the curves, I have made a separate study of each curve, and have made cross-sections of the hill-sides, at intervals of 100 feet

or less, on all difficult ground, from which tolerably accurate estimates could be made of the quantities of earth or rock to be removed, or of wall to be built, to effect any desired change within reasonable limits.

In making up these estimates, I have taken first as a standard a minimum radius of 1,146 feet, or 5° per 100 feet, in five of the most difficult places, with a minimum of 1,432 feet radius, or 4° per 100 feet at other points. This is about the same standard as was adopted upon the Mountain Section of the Boston & Albany Railroad. This line is drawn in blue on the large maps submitted herewith.

It is to be observed that the sharpest curves occur, either on gradients descending, or but very slightly ascending, in the direction of the ruling traffic, moving eastward, so that their effect will not be found to limit the length or weight of freight trains. This will be governed by the maximum grade ascending eastward.

For this reason, and on account of the very great cost of attaining such a high standard, I have made another estimate on a line drawn in red ink upon the large maps, using as a standard a minimum radius of 955 feet (6° per 100 feet) in four of the most difficult places. This estimate gives a total cost of \$1,510,300, while the blue line, using a larger radius in four places, costs \$161,362 more, making in all \$1,671,662, exclusive of land damages.

In nearly all the changes on which I have estimated the cost, and which are represented on the accompanying large maps by the blue and red lines, it has been thought best to adopt the same general location that the old line is on, using the old land and grading for a large part of the way, the changes extending over 75 per cent. of the whole track, leaving 25 per cent. untouched, while of the 75 per cent. where changes occur a large part of the old work is used. By this means local interests have been protected, which might have been injuriously affected by a more radical change, for which change, with the exception named below, there seems to be no good reason. This is particularly the case with the whole of the portion above Bardwell's Ferry station. Below this point there are other lines to be considered, and a wider choice. Before deciding upon any definite course for future construc-

tion, farther examination should be made as to the merits of such other lines.* There is an apparently very practicable line, formerly called the Deerfield Route, described by Mr. J. W. Brooks in his report, as follows :—

“ Another line was surveyed from the Vermont & Massachusetts Railroad to Bardwell’s Ferry. This line commences about $1\frac{1}{2}$ miles east of the present terminus of the Troy & Greenfield Railroad, and keeping on the south side of the Deerfield River crosses the Connecticut River Railroad, south of the Cheapside Bridge over the Deerfield River ; thence, nearly parallel with that road, to Deerfield Centre, and, crossing the Deerfield River at Martin’s Falls, it joins the present location at Bardwell’s Ferry.

“ The whole length of this line is $8\frac{11}{100}$ miles ; it has 489° less curvature, and 150 feet less rise and fall than the present route, and reduces the maximum grade ascending westward from $58\frac{6}{10}$ to $50\frac{16}{100}$ per mile ; but this latter is not so important as might appear, for the grade ascending east, in the direction of the heaviest trade, is quite as strong relatively as the $58\frac{6}{10}$ rising west in the present line.

“ Its adoption would involve the abandonment of $7\frac{7}{10}$ miles of the present track ; as a through line it would save a mile in distance.”

This Deerfield line was estimated by Mr. James Laurie, C. E., in his report to the commissioners, January 10, 1863, to cost \$220,000 for the $8\frac{11}{100}$ miles. Assuming his estimate of quantities to be correct, and carrying them out at present prices for similar work, and adding for superstructure, we obtain a total of \$551,855, which is to be compared to the sum of \$593,615, and the land damages estimated as needed for an improvement of the present location east of the point of divergence as represented by the *blue* line on the large maps, and compared to the sum of \$578,455, as represented by the *red* line, between the junction of the Vermont and Massachusetts Railroad and a point common to both below Bardwell’s Ferry.

Thus the Deerfield line appears, not only to possess advantages over the present line with its improvements, both in distance and rise and fall, but actually costs \$26,600 less, if we may trust Mr. Laurie’s quantities, than the proposed

*Two of these alternative lines are shown on the small map printed herewith.

improvements on the lowest standard as to curvature, and \$41,760 less than those on the highest standard on that portion of the old line which it is intended to replace.

Mr. Laurie, in his report to the commissioners (page 172), speaks of this line through Deerfield, as follows:—

“Viewed as a through line, the saving of nearly a mile in distance, 489° of curvature, the reduction of the maximum grade and the avoidance of the Green River Bridge with its sharp curve would be of considerable importance.”

These advantages are to be weighed against the local business of Greenfield and Turner's Falls, which may be better accommodated otherwise.

For this end still another line has been surveyed recently (see small map printed herewith), which leaves the present line of the Troy & Greenfield Railroad about $1\frac{1}{2}$ miles west of the present junction with the Vermont & Massachusetts Railroad, and passing through Greenfield and Turner's Falls, intersects the present Vermont & Massachusetts track at Grout's Corner. This line is found to be a trifle longer (565 feet) than the present through line, but accommodates Greenfield and Turner's Falls to good advantage. It requires about $9\frac{3}{10}$ miles of independent construction, of which about two miles lie west of the Connecticut River Railroad, replacing nearly the same length of the present line of the Troy & Greenfield Railroad. This two miles, if built for a single track, would cost about \$166,000 less than the improvement noted on my large maps on that part of the line which would be replaced by it between Blakely Hollow and the present junction.

Although the northern line is slightly longer as a through line than the present one, the large local interests at Greenfield and Turner's Falls may do much towards its construction; while the greater chances of developing business from these towns by building a thoroughfare *through* them, than by having them on one side, merits due consideration. The portion of this line lying east of the Connecticut River Railroad is estimated by Mr. Wm. P. Grainger, C. E., who made the surveys, to cost \$361,000 for a single-track line and wooden bridges.

For the sake of exhibiting in a concise form the nature of

the changes contemplated, and the comparative merits, as to curvature, of other lines in mountainous districts, I have prepared tables, which will be found in the Appendix.

As to the propriety of bringing the location of this line up to either of the standards upon which these estimates are based, there may be some difference of opinion even among experts. Some arbitrary standards must be taken for the purposes of a preliminary estimate, though it may be found perfectly proper to depart from these, in construction, in extreme cases, where the large expense to be incurred may prove incommensurate with the advantage to be gained.

Such questions can better be settled in detail whenever the work of construction shall be done.

In deciding such questions, it should be borne in mind that a sharp curve, say of 1,000 feet radius, is not a serious obstacle to a freight traffic when it occurs upon gradients descending, or but slightly ascending in the direction of the heavy traffic, and nearly the whole of the thirty miles we are now considering, between Greenfield and the Tunnel, presents this mitigating feature.

Were a passenger traffic to be provided for, however, such curves would present an obstacle by limiting the speed at which trains could be moved with safety, especially when running along the edge of high declivities, beside adding considerably to the wear and tear of permanent way and rolling-stock.

As to the standard held in view in regard to permanence of work in the grading, masonry and bridging, I do not anticipate much difference of opinion, though a large expense may be incurred. All the leading railroad lines in the country have, after twenty years' experience, abandoned wood as an improper material for bridge-building, whenever the traffic has developed to any considerable importance. The building of wrought-iron bridges has in the same time had a large development, in which many reliable firms are now engaged. Some of the first efforts in this direction were failures, having been constructed without sufficient allowance for the depreciation of metal under vibration, and such cases have done much to throw iron bridges into disrepute; but the more recent works have generally been governed in this respect by

the rules adopted by the English and French governments for similar cases, promising entire safety for a long period, while the workmanship of American artisans is not excelled by any in other countries.

As to permanence in grading and masonry, it is hardly necessary to point out the folly of constructing such work upon improper principles or on insecure foundations. The experience of the past five years has shown to all who have observed the character of the Deerfield River, that it is a stream not to be trifled with or ignored with impunity.

In judging of the propriety or necessity of making such improvements in the Troy & Greenfield Railroad, the only question seems to me to be as to the *time* when it shall be done. There is no doubt that the present line is good enough for present traffic, and with a few months' work with a gravel train and a renewal of the track and some additional sidings, it would doubtless answer very well for as large a freight traffic as can be conducted on a single line of rails.

But if it be taxed with any considerable passenger traffic, with such an increase of freight as may very likely be developed after opening the Tunnel, a double line of rails from Troy to Fitchburg will become indispensable. The changes of location and the work of grading for a double track, can be carried on to much better advantage *together* than *separately*, and as they will in all probability be demanded by the increase of traffic at one and the same time, it has, therefore, seemed best to me to make an estimate of the cost of both, which is herewith presented in detail.

Respectfully submitted by your obedient servant,

EDWARD S. PHILBRICK,

Civil Engineer.

Boston, January 6, 1874.

APPENDIX.

Summary of Estimate of Cost of the proposed improvements of the Troy & Greenfield Railroad, as indicated by the blue line on the accompanying Map.

MATERIAL.	FOR SINGLE TRACK.			FOR DOUBLE TRACK.		
	Quantity—Yds.	Price.	Cost.	Quantity—Yds.	Price.	Cost.
Earth excavation,	1,148,134	\$0 45	\$516,660 00	1,496,545	\$0 45	\$673,445 00
Loose rock,	7,948	1 00	7,948 00	10,438	1 00	10,438 00
Solid rock,	144,391	2 00	288,782 00	216,244	2 00	432,488 00
Tunnel at North Adams,	—	—	50,000 00	—	—	50,000 00
Pier masonry,	2,548	20 00	50,960 00	3,596	20 00	71,920 00
Abutment masonry,	12,288	15 00	184,320 00	15,591	15 00	233,865 00
Arches,	5,997	15 00	89,955 00	8,545	15 00	128,175 00
Culverts,	13,908	5 00	69,540 00	17,923	5 00	89,615 00
Retaining walls,	12,703	4 00	50,812 00	25,000	4 00	100,000 00
Rip-rap,	153,077	1 75	267,885 00	153,077	1 75	267,885 00
Bridges,	—	—	94,800 00	—	—	217,700 00
				Grading, &c., on 6.65 miles west of North Adams, 43 $\frac{3}{4}$ miles at 2d track, \$11,000,		
Total, . . . . .	. . . . .	. . . . .	\$1,671,662 00	Total, . . . . .	. . . . .	\$2,854,551 00

Comparative Curvature of the Present Line of the Troy & Greenfield Railroad and the Proposed Line, drawn in Blue on Map.

Degrees.	Radius—feet.	PRESENT LINE.		PROPOSED LINE.	
		Total Curvature.	Length of Curve—feet.	Total Curvature.	Length of Curve—feet.
1, . .	5,730	8° 21'	1,060	—	—
2, . .	2,865	198° 28'	10,888	121° 21'	6,785
3, . .	1,910	430° 56'	14,267	626° 11'	21,383
4, . .	1,432	735° 45'	18,807	1,533° 21'	39,834
5, . .	1,146	1,000° 49'	19,762	427° 23'	8,540
6, . .	955	1,125° 54'	19,044	—	—
7 to 11, .	819 to 522	486° 49'	6,071	—	—
—	—	3,987° 02'	89,899	2,708° 16'	76,542

Present Line.

Curvature per mile,	133°
Percentage of line curved,	56

Proposed Line.

Curvature per mile,	90°
Percentage of line curved,	49

Table showing saving by adopting 6° per 100 feet as sharpest curve, in place of 5° .

This contemplates the blue line to be modified as shown in *red* upon the map at four places, viz., Bardwell's Ferry bridge, West Deerfield, above Zoar, and near the tunnel station. Whole length of line changed, 9,490 feet. Total amount of curvature not changed.

Red Line, for Single Track.

Saving of Material.	Quantity.	Price.	Saving of Cost.
Rock,	41,531 yards, .	\$2 00	\$83,062 00
Pier masonry,	980 " .	20 00	19,600 00
Abutment masonry, . .	1,780 " .	15 00	26,700 00
Bridging,	400 lineal feet,	80 00	32,000 00
Total saving, as compared with blue line,			\$161,362 00

Double Track. Saving by adopting Red Line in place of Blue.

Saving of Material.	Quantity.	Price.	Saving of Cost.
Rock,	57,923 yards, .	\$2 00	\$115,846 00
Pier masonry,	980 " .	20 00	19,600 00
Abutment masonry, . .	1,780 " .	15 00	26,700 00
Bridging,	500 lineal feet,	80 00	40,000 00
Total saving, as compared with blue line,			\$202,146 00

Comparison of Lines via Greenfield and via Deerfield.

M A T E R I A L S.	JAS. LAURIE'S LINE VIA DEERFIELD.			BARDWELL'S FERRY TO JUNCTION* VIA GREENFIELD. PRESENT JUNCTION.		
	Quantity.	Price.	Value.	Quantity.	Price.	Value.
Earth and ballast,	275,600 cub. yds.,	\$0 45	\$124,020 00	554,902 cub. yds.,	\$0 45	\$249,706 00
Solid rock,	82,000 "	2 00	164,000 00	50,515 "	2 00	101,030 00
Loose rock,	5,000 "	1 00	5,000 00	—	1 00	—
Box culverts,	947 "	5 00	4,735 00	2,689 cub. yds.,	5 00	13,445 00
Arch culverts,	2,484 "	15 00	37,260 00	5,267 "	15 00	79,005 00
Bank wall,	500 "	4 00	2,000 00	4,055 "	4 00	16,220 00
Rip-rap,	1,200 "	1 75	2,100 00	5,333 "	1 75	9,334 00
Road-bridge masonry,	1,120 "	10 00	11,200 00	†1,445 "	20 00	28,900 00
River-bridge masonry,	1,470 "	15 00	22,050 00	3,665 "	15 00	54,975 00
Foundations,	—	—	1,500 00	—	—	—
Bridge superstructure,	370 lin. feet,	80 00	29,600 00	500 lin. feet,	80 00	40,000 00
Road-bridge superstructure,	100 "	15 00	1,500 00	—	—	1,000 00
Altering town roads,	—	—	1,500 00	—	—	—
Farm-crossings and cattle-guards,	—	—	2,000 00	—	—	—
Land damages,	—	—	39,000 00	—	—	—
Fencing,	3,700 lin. rods,	2 20	8,140 00	—	—	—
Track-laying, iron, &c.,	8.75 miles,	11,000 00	96,250 00	—	—	—
Totals, . . . . .	. . . . .	—	\$551,855 00	—	—	\$593,615 00

† Pier masonry.

* Blue line on Map.

Comparative cost of line indicated in blue ink on map, from present junction of Vermont & Massachusetts Railroad to Blakely Hollow, with line of W. P. Granger, from Connecticut River Railroad to Blakely Hollow.

Blue line on the Map for single track from Junction of the Vermont & Massachusetts Railroad to Blakely Hollow.

Material.	Quantity.	Price.	Cost.
Earth,	284,175 yards, .	\$00 45	\$127,879 00
Pier masonry,	1,445 " .	20 00	28,900 00
Abutment masonry, . .	2,747 " .	15 00	41,205 00
Arch masonry,	2,620 " .	15 00	39,300 00
Bridging,	500 lineal feet,	80 00	40,000 00
Total,			\$277,284 00

Line of Survey of W. P. Granger, Blakely Hollow to Connecticut River Railroad, single track.

Material.	Quantity.	Price.	Cost.
Earth,	84,300 yards, .	\$00 40	\$33,720 00
Rock,	3,735 " .	2 00	7,470 00
Bridge masonry,	2,980 " .	15 00	44,700 00
Culvert masonry,	190 " .	5 00	950 00
Bridging,	300 lineal feet,	80 00	24,000 00
Total,			\$110,840 00

Comparison with other Lines.

	Maximum grade per mile, rising easterly.	Maximum grade per mile, rising westerly.	Rise and fall.	Whole length.	Sharpest Curve.	Percentage straight.	Percentage curved.	Degrees of Curve per mile.	T. & G. R. R. Estimated cost of changes.
Between Hoosac Tunnel and Connecticut Valley.	30.6	58	810	31.6*	10°	44	56	133	-
	23.8	50	767	30.8	5°	51	49	90	\$1,671,662
	23.8	50	767	30.8	6°	51	49	90	1,510,300
	-	50	660	30.3	6°	-	-	94	1,483,700†
	-	50	749	-	5°	-	-	-	1,344,310†
Boston & Albany R. R.,	75	83	5,606	200	5°	-	-	41.1	-
Providence & Worcester R. R.,	-	-	582	43.4	8°	-	-	58.7	-

* The distances in the column of "lengths" count from the eastern portal of the Hoosac Tunnel to a common point on the Vermont & Massachusetts Railroad 1½ miles south of the present junction.

† The cost set against the lines via Deerfield & Turner's Falls includes their construction from the east end of the Hoosac Tunnel, following the red line on the map, or the blue line where no red one is drawn, to the points of divergence; thence over the independent line via Deerfield to its junction with the Vermont & Massachusetts Railroad, 1½ miles south of the present junction, and upon the line towards Turner's Falls as far as its intersection with the Connecticut River Railroad at Greenfield.

Comparison with other Lines—Concluded.

	Maximum grade per mile, rising easterly.	Maximum grade per mile, rising westerly.	Rise and fall.	Whole length.	Sharpest Curve.	Percentage straight.	Percentage curved.	Degrees of Curve per mile.
Cheshire R. R.,	—	60	—	53.6	5°	—	—	59°
Fitchburg R. R.,	34.3	40.7	1,052	51.0	5°	—	—	33.2°
Vermont & Massachusetts R. R.,	48	58	1,798	69.0	5°	—	—	47.8°
Erie Railroad, Delaware Division,	—	—	—	103.3	6°	—	54	88°
Baltimore & Ohio R. R., 4 divisions as below,*	39.6	116.0	9,643	379	9° 33'	42	58	119°
“ “ Baltimore to Martinsburg,	39.6	—	2,033	99	9° 33'	45	55	121°
“ “ Martinsburg to Piedmont,	39.6	—	1,029	107	5° 42'	41	59	80°
“ “ Piedmont to Grafton,	—	116.0	4,681	74	9° 33'	46	54	152°
“ “ Grafton to Wheeling,	—	79.2	1,900	99	9° 33'	37	63	154°
Pennsylvania Central,	52.8	95	—	—	8° 45'	—	—	—

* I am indebted to Mr. B. D. Frost, C. E., for the information given above concerning the Baltimore & Ohio and Pennsylvania Central lines. The characteristics of the Massachusetts roads and the Erie Railway are taken from their official reports.



